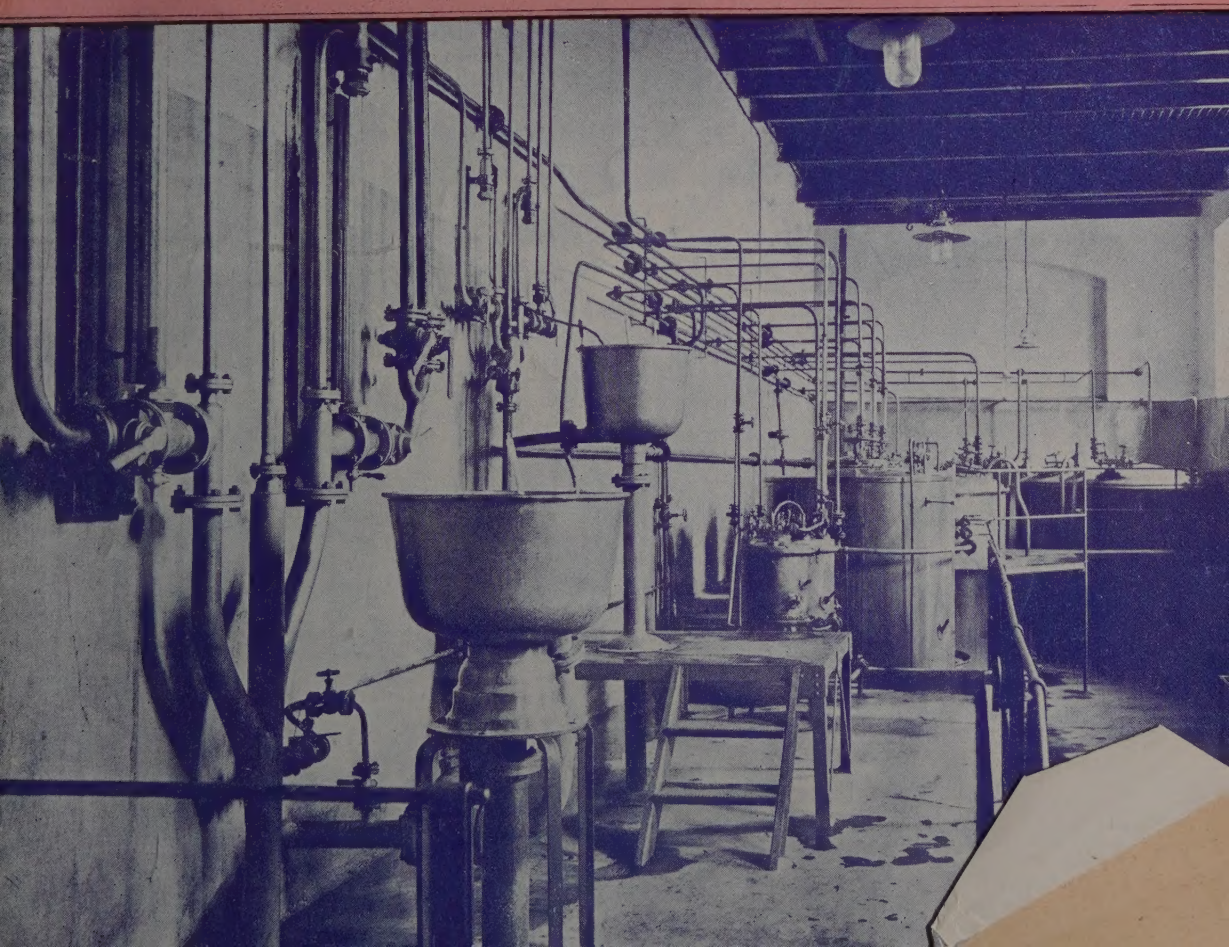
BINDAL, A. N. et. al

IMPERIAL MYCOLOGICAL INSTITUTE
7.2.45

Journal of SCIENTIFIC AND INDUSTRIAL RESEARCH

VOL. III] DECEMBER 1944 [No. 6



Editorial Board

S. S. Bhatnagar, Kt., O.B.E., F.R.S., D.Sc., F.Inst.P., F.I.C.
Director, Scientific and Industrial Research (Ex-officio Chairman).

H. Ahmed, Esq.,
Deputy Secretary to the Government of India, Department of Industries and Civil Supplies, New Delhi.

J. C. Ghosh, Kt., D.Sc., F.N.I.
Director, Indian Institute of Science, Bangalore.

Jivaraj Mehta, M.D., M.R.C.P., F.C.P.S.
Khambata Hall, 16, Altamont Road, Bombay.

S. Krishna, C.I.E., Ph.D., D.Sc., F.I.C., F.N.I.
Forest Research Institute, Dehra Dun.

K. S. Krishnan, D.Sc., F.R.S.
Allahabad University, Allahabad.

B. L. Manjunath, B.A., M.Sc., D.Phil. (Oxon.)
Chief Editor, Dictionary of Raw Materials of India.

Mata Prasad, D.Sc., F.I.C., F.N.I.
Royal Institute of Science, Bombay.

Nazir Ahmad, O.B.E., Ph.D.
Director, Technological Laboratories, Indian Central Cotton Committee, Bombay.

M. Qureshi, D.Sc.
Department of Chemistry, Osmania University, Hyderabad (Deccan).

J. N. Sen-Gupta, M.B.E., M.A., B.L.
Industrial Economist, Council of Scientific and Industrial Research, New Delhi.

M. N. Saha, D.Sc., F.R.S.
University College of Science, Calcutta.

B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc.
(Editor and Ex-officio Secretary)

★ ★ ★

P. Chaudhuri (Art Editor)

★ ★ ★

The Editorial Board in its work of examining papers received for publication will be assisted, in a honorary capacity, by a large number of distinguished scientists working in various parts of India.

Editorial communications, and books and periodicals for review, should be addressed to the Editor, *Journal of Scientific and Industrial Research*, University Buildings, Delhi.

Communications regarding subscriptions and advertisements should be addressed to The Secretary, Council of Scientific and Industrial Research, University Buildings, Delhi.

Annual Subscription:
Rs. 9/- (Inland) 18 Sh. (Foreign)

Single copy:
Re. 1/- (Inland) 2 Sh. (Foreign)

MODI INDUSTRIES

A RECORD OF INDUSTRIAL DEVELOPMENT

"MODI WORKS" at Modinagar (Begamabad), U. P., are an example of courage and success in Industry of Rai Bahadur G. M. Modi, under whose control and initiative, the following works have come into existence in Modinagar:

1. **Modi Sugar Mills**
   Producers of "Crystal Sugar" and "Golden Syrup."
2. **Modi Vanaspati Mfg. Co.**
   Pioneers in introducing "Cotton Seed" Product.
   "KOTOGEM"
   (An Ideal Cooking Medium)
3. **Modi Soap Works**
   Manufacturers of Soap from hydrogenated oils.
   "PREFECT"
   (Toilet and Shaving Soap)
4. **Modi Tin Works**
5. **Dehydration of Foodstuffs Plant**
   Where vegetables and other foodstuffs are dried and compressed for the use of Defence Forces. It is an example of what India can do without foreign machineries and guidance.
6. **Modi Oil Mills**
   For vegetable refined oils and lubricants.
7. **Modi Biscuit Plant**
   A very extensive and up-to-date biscuit factory is under construction.
8. **Modi Confectionery Plant**
   For high class Confectionery, Lozenges, Toffees, Icing Sugar, Golden Syrup, etc.

MODI INDUSTRIES

MODINAGAR - - - BEGAMABAD, U.P.

Managing Director:
Rai Bahadur G. M. Modi.

Managing Agents:
R. B. Multanimal & Sons, Ltd.

M. C. I. PRODUCTS

TRADE MARK

HIGH QUALITY DRUGS—Ammonium Chloride, Calcium Lactate, Ferrous Sulphate, Magnesium Sulphate, Potash Acetate, Potash Nitrate, Pure Acids, Sodium Chloride, Sodium Acetate, etc., etc. Guaranteed to B. P. specification.

B. P., C.P., AND A.R. STANDARD LAB. CHEMICALS—Acetic Acid, Hydrochloric Acid, Lactic Acid, Nitric Acid, Sulphuric Acid, Iron Sulphide, Potash Chloride, Potash Sulphate, Calcium Chloride, Sodium Chloride, etc., etc.

HEAVY CHEMICALS—Hydrochloric Acid, Lactic Acid, Nitric Acid, Sulphuric Acid, Alumina Ferric, Alumina Sulphate Iron-free quality, Magnesium Sulphate, Potash Alum, Sodium Sulphate, Iron Sulphate, etc., etc.

Please address enquiries to—

MINING & CHEMICAL INDUSTRIES LTD.

Jumna Bridge, AGRA, U.P. or

M-1 Connaught Circus, Post Box 42, New Delhi.

We import- Industrial and Pharmaceutical Chemicals, Patent Medicines, Surgical Sundries like Record and all Glass Syringes, Thermometers, etc., Leather Picking Bands, Provisions, Pure Spanish Saffron, Mineral Ores like Fluorspar, Ferrosilicon, etc., etc.

&

We export- Textiles, Jute Manufactures, Coir, Yarn and Manufactured Products, Crude Drugs, Medicinal Herbs, etc., etc., etc.

SEPULCHRE BROTHERS [INDIA] LTD.

Head Office: BOMBAY **Branch: MADRAS**

REPRESENTED THROUGHOUT GREAT BRITAIN AND BRITISH COMMONWEALTH, U. S. A., SOUTH AMERICA, SPAIN & PORTUGAL

TELEGRAMS "BELEAST"	BOMBAY	MADRAS
TELEPHONE 23614	P. O. BOX No. 754	P. O. BOX No. 91

Telegrams: "TECHLAB"

Telephone: 37204 (2 lines)
Outside Office Hours: 61372, 61448

RAJ-DER-KAR & CO.

COMMISSARIAT BUILDING, HORNBY ROAD, FORT, BOMBAY

Manufacturers of:—

(1) **Nirvatak High Vacuum Pump;**

(2) **Post Office and Resistance Boxes, etc.;**

(3) **Gas Plants and Water Distillation Stills, etc.**

Sole Agents for:—

(1) Coleman Electric Co. (U.S.A.), Maywood, Ill.
pH Electrometers.

(2) W. A. Taylor & Co., Inc. (U.S.A.), Baltimore, Md.
pH Comparators.

(3) Wheelco Instruments Co. (U.S.A.), Chicago.
Pyrometers & Electrical Instruments.

(4) Gaertner Scientific Corporation (U.S.A.), (for Western India).
Optical Instruments.

(5) Distillation Products, Inc. Rochester, N.Y. (U.S.A.)
Oil Diffusion Pumps.

(6) Hunter Machines Co., Ltd., Nitshill, near Glasgow.
Hunter Emulsors.

Dealers in:—

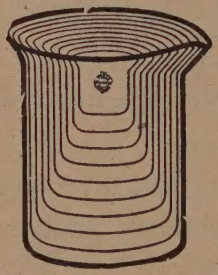
(1) All Types of Optical, Physical, Chemical, Electrical and Biological Instruments.

(2) All Laboratory Glasswares, Procelainwares, Silicawares, Etc.

(3) All Types of Pure and Analytical Laboratory Chemicals.

PYREX

LABORATORY GLASSWARE



THE BEST LABORATORY GLASSWARE SO FAR KNOWN TO THE SCIENTISTS

SOLE AGENTS IN INDIA:

THE SCIENTIFIC INSTRUMENT COMPANY LIMITED

5-A, Albert Road	11, Esplanade East	240, Hornby Road	30, Mount Road
ALLAHABAD	CALCUTTA	BOMBAY	MADRAS

CONTENTS

	Page
INSTITUTE OF FERMENTATION TECHNOLOGY	237
ECONOMIC DEVELOPMENT OF INDIA	239
SURVEY OF THE PRODUCTION OF INSULATING MATERIALS AND DIELECTRICS FOR HIGH FREQUENCIES .. .. *Sudhindra Narayan Sen-Gupta*	240
STUDIES ON INDUSTRIAL ENZYMES Part I—Comparative Study of the Brans, the Husks and the Oilcakes as Raw Materials for the Production of Diastase .. .. *A. N. Bindal and M. Sreenivasaya*	245
FILTER MEDIA FOR FINE FILTERS OF THE PORTABLE PRODUCER-GAS PLANTS .. .. *Lal C. Verman, K. Achuthan Nair, M. L. Khanna and S. K. Das Gupta*	251
OBITUARY Dr. E. L. C. Clegg	258
ON SWEETENING OFF FILTER PRESS-CAKE .. .. .. *J. G. Shrikhande and S. B. Lal.*	259
REVIEWS	262
LETTERS TO THE EDITOR Ultrasonic Velocities and Adiabetic Compressibilities in some Essential Oils—Part 2 .. .. *A. Pande, M. Pancholi and S. Parthasarathy*	263
Extraction of Rubber from *Cryptostegia Grandiflora* .. *S. S. Bhatnagar, Karimullah and Uma Shanker*	263
INDUSTRIAL UTILIZATION OF MAHUA .. .. *N. G. Chatterji*	265
THE USE OF PRODUCER-GAS FOR MOTOR TRANSPORT Conference of Technicians in New Delhi .. .. .. *H. B. Dunnicliff*	268
THE TINPLATE INDUSTRY IN INDIA	273
THE SINGHBHUM COPPER BELT AND THE INDIAN COPPER CORPORATION LTD.	275
NOTES AND NEWS	279
RADIO POWER FOR PROCESSING CHEMICAL MATERIALS ..	281
REPORTS FROM STATES AND PROVINCES	283
INDIAN PATENTS	284

(For Index to Advertisers, *see* page xii)

Cover Page Illustration—Pure yeast culture and prefermentation vessels with continuous wash preparation apparatus in the foreground (*see* page 265).

The Council of Scientific and Industrial Research assumes no responsibility for the statements and opinions advanced by contributors.

The First and Still the Foremost Manufacturers in the EAST.

Journal of
Scientific and Industrial
Research

Vol. III DECEMBER 1944 No. 6

INSTITUTE OF FERMENTATION TECHNOLOGY

THE study of industrial fermentations has received active encouragement and strong support from the *Council of Scientific and Industrial Research* since its inception. Early in 1940, the *Council* allotted funds for the organization and maintenance of a National Collection of Type Cultures at the *Indian Institute of Science, Bangalore*, and constituted a research committee for the promotion of investigations on the science and technology of fermentation processes. Under the fostering care of the *Council*, an active school of fermentation technology is being built up in the country and the results obtained under the various schemes of research have demonstrated unequivocally that the scope for the development of fermentation industries in a predominantly agricultural country like India, is practically unlimited.

In any inquiry relating to the possibilities for the future development of an industry, two questions present themselves. Firstly the availability of raw materials, and secondly the present status of the industry in the country, and the progress achieved and the trends of development in other industrially advanced countries. The former provides an estimate of the means available while the latter furnishes a measure of the attainable targets within a reasonable period through a rational utilization of the resources. The raw materials required for the fermentation industry are mostly drawn from agriculture and although, at present, India has hardly any surplus of cereals or tubers, it is nevertheless rich in a variety of farm wastes and by-products of agricultural industries which serve as excellent raw materials for the industry. Further, India can provide an abundant supply of many kinds of forest produce, and the need for enhancing food production, which has become compelling and urgent, will release a large quantity of raw materials which can be exploited for industrial development. It is manifest that the raw material resources of India for fermentation industries are not only abundant, but also are perennial.

There are only two fermentation industries in this country at present—the brewing and the distillation industries, producing alcoholic beverages and industrial alcohol respectively. The brewing industry has hardly attained the stage of self-sufficiency. Either in quantity or quality, the demands of the Indian market are not being met; this is evident from the fact that alcoholic beverages valued at about 2.5 crores of rupees are annually imported into this country. The production of industrial alcohol, despite the stimulus provided by the war, is inadequate and Indian requirements are being met by supplementing indigenous production with imports from Australia and South Africa. In marked contrast to this position, fermentation industries occupy a unique and important place in the industrial structure of

Europe and America, and provide industrial solvents, organic acids, vitamins and vitaminic concentrates, yeast and protein foods, penicillin-like drugs and a large number of other commercially valuable chemicals. Before the outbreak of the war, American production of industrial alcohol reached the colossal quantity of 223,000,000 gallons; America was producing also about 10,500,000 lbs. of citric acid, 500,000 lbs. of calcium gluconate, 900,000 lbs. of edible lactic acid and 100,000 lbs. of sorbose (for the synthesis of vitamin C) by fermentation processes. Recent researches have led to spectacular improvements in processes and products and resulted in the creation of new products of commercial value.

In the course of an address on post-war plans for industrial development in India, delivered before the *Institution of Engineers* (8th September), Sir S. S. Bhatnagar made the following significant statement:

> "I attach great importance to biochemical and fermentation industries. They have revolutionized modern chemical industry in America and Germany and present an attractive field for our industrial activity."

It is probable that fermentation industries have received a high priority in the post-war plans; the *Council of Scientific and Industrial Research* has apparently included industrial fermentations in the selected group of subjects for intensive development research.

Fermentation industries constitute a distinct and well-defined group of industries. The problems of research and development connected with these industries, which have in common the utilization of biochemical activities of micro-organisms for the production of industrially indispensable and commercially valuable chemicals, are also of a specialized character. Recent discoveries have shown that the achievements of the past in this field, are likely to be dwarfed by the possibilities of the future. Considering the nature and magnitude of the problems awaiting study, either with respect to the improvement of the existing industries or with the establishment of new ones, and the assured practical value of such investigations, there is urgent need for promoting the intensive study of industrial fermentations. This is best achieved by the establishment of a Research Institute, exclusively devoted to the study of the fundamental, applied and engineering aspects of fermentation technology.

The Institute of Fermentation Technology, which is contemplated, should have as one of its primary objectives the training of fermentation technologists and industrial microbiologists not only for undertaking research and development work, but also for taking charge of industrial operations. There is a considerable demand for fermentation specialists by the existing industries and more of them will be required in the future as the industrial possibilities of fermentation processes are recognized. There is the imperative and urgent need for rationalizing the sugar industry and stabilizing its position during the post-war period. One of the ways of achieving this, is to secure the scientific utilization of its by-products, the successful accomplishment of which needs the expert knowledge of the fermentation technologists. Industrial microbiologists are needed by the pharmaceutical and food industries which are being established. It is estimated that some 250 technical men of this type can be absorbed with advantage by the several industrial organizations in the country. Facilities for training now exist, in the Fermentation Technology Section of the *Indian Institute of Science*, but the magnitude of the problem is such that only a fully organized and well-equipped institute can undertake this task. The institute should also have facilities for the study of the fundamental aspects of fermentation biochemistry and microbiology. A knowledge of the nature and mechanism of the transformations involved in a fermentation process is of immense value in exploiting the process for commercial ends. The institute should also be provided with a chemical engineering laboratory and a pilot plant house.

The *Council of Scientific and Industrial Research* has shown commendable awareness of the possibilities of fermentation industries in India. By organizing the National Collection of Type Cultures and financing a large number of schemes of research on industrial fermentations, the *Council* has already prepared the groundwork for the establishment of a research organization for the systematic study of industrial microbiology. It is to be hoped that the Institute of Fermentation Technology would find a place in the network of National Laboratories for which plans are under preparation.

ECONOMIC DEVELOPMENT OF INDIA

INDIAN SCIENTIFIC MISSION IN THE U. K.

THE following excerpts are taken from *Reuter's* summary of the Proceedings of the *East India Association* meeting held on 19th October.

In his address to the *Association*, Sir Shanti Swarup Bhatnagar observed:—

"Indians, rightly or wrongly, feel the economic disadvantages to India arising from laws, customs and other legal financial measures, to be a deliberate attempt to keep India industrially backward. These suspicions are unpleasant but they cannot be disregarded. Such disadvantageous measures are being slowly withdrawn, but great speed is needed in establishing goodwill if the two countries have to work in close collaboration. Fortunately there are signs of the dawn of new wisdom on the economic firmament, as it is becoming increasingly clear that no people, however undeveloped, can remain merely as wards of developed nations. Farsighted thinkers in the economic and industrial fields now thoroughly opposed the use of economic power to exploit or pauperize an undeveloped nation. In this world where distances are being annihilated and new sources of raw materials are being tapped and produced, such a principle is bound to be universally recognized as a great stabilizing force.

"India, too, will accept this if she is made a free and equal partner in the British Commonwealth, able to manage her own destiny without outside interference. The scientific approach to the future welfare of England and India lies in the final honourable settlement between the two countries, followed by an understanding that there will be a trade political agreement which will guarantee planned industrial progress for both. There are still very many indeed in India who wish to remain friendly with Britain within Britain's Commonwealth. I agree, however, with Professor Hill, that disaster lies ahead if India's industrial development and national welfare are not immediately attended to. Political controversies may take time to settle, but nobody will allow India's national welfare to suffer for long. Scientists and wise industrialists in India, England and other Allied countries, should co-operate to draw up a programme of work which will lead to planned progress and development."

The Right Hon'ble Leopold S. Amery, M.P., Secretary of State for India, said:—

"Undoubtedly it was true that political and, still more, industrial relations between India and this country were affected by a suspicion that this country, or at any rate the industrialists of this country, would wish to obstruct the progress of Indian industry in the interests of the British export trade. . . .

"He could say unhesitatingly that the Government of this country wanted to see Indian industry develop to the fullest extent, and so far as the industrial section of this country was concerned, he had discussed the subject with industrialists and the last thing that they had in mind was the idea that the British export industry could best prosper by India's being held back in industrial development. On the contrary, their belief was that the more prosperous India could make herself, the more she would, in the ordinary course of the needs of consumers and the needs of factories for capital goods, have recourse to help from outside; and that, provided we did not think that India must always buy what we had been accustomed to sell her, but were prepared to provide in quality and in kind the goods that India needed, there would always be a fruitful opening for British trade with India and an even more fruitful opportunity for intimate co-operation and collaboration between British industry and the nascent industries of India.

"We in this country looked forward to the maximum development of India's resources, and undoubtedly we too had moved very far from what might be called the mere exporting and trading conception of national development. We realized that the more a country could within itself balance the different elements of production, and do so in order to extract the utmost possible value not only from its material resources but even more from its human resources, the better for that nation and the better, through the consequent overspill of trade which would always occur, for the world as a whole. . . .

"He thought that we were more and more conceiving of nations or groups of nations as the basis of systems of intensive full development, stable employment and human well-being; and that was not in the least inconsistent with a wide measure of interchange of products and of industrial collaboration. Still less did we conceive of scientific development as something which would be carried on in isolation and in a spirit of jealous monopoly by any one nation. Whatever administrative or economic or monetary policy could do, it could avail very little in the world to-day unless industry had behind it science and research. He fully agreed with Sir Shanti that, intimate scientific co-operation between their two countries, and between all the countries of the British Commonwealth and indeed within the wider circle of the world generally, was perhaps not only the most fruitful method of collaboration from the point of view of practical results but also the field in which collaboration came most naturally and most beneficially smoothed the way for wider collaboration in other fields."

SURVEY OF THE PRODUCTION OF INSULATING MATERIALS AND DIELECTRICS FOR HIGH FREQUENCIES

By SUDHINDRA NARAYAN SENGUPTA

(*University College of Science, Calcutta*)

THE increasing applications of radio and other high frequency apparatus has created a great demand for special types of insulating materials. An essential requirement of such materials is that they must have low loss for high frequency currents. An insulating material quite suited for low frequency or for high voltage may, for this reason, be quite useless for high frequency. Two types of materials are generally used as insulators in high frequency apparatus,

(1) Synthetic resins and

(2) Ceramics.

Of these, synthetic resins have the important advantage that they can be easily moulded into required shapes and sizes and that the high frequency properties can be varied by changing their chemical compositions. Amongst well-known synthetic plastics having low loss at high frequencies, mention might be made of *Paxoline*.

Ceramics are also being increasingly used for high frequency work. They are mechanically strong and can be blended together to give a wide range of dielectric properties. However, unlike synthetic resins, they cannot be machined.

Investigations are constantly being made in the Western countries to improve upon the high frequency properties of both the types of materials by varying their compositions. In India, although both synthetic plastics and porcelains are being manufactured for general use, their suitability for use in high frequency work has not received any attention. In view of the fact, that owing to restrictions in import, there has arisen a local demand for high frequency insulating materials, the present investigation was undertaken to find out if any of the materials manufactured in this country have sufficiently low loss to warrant their use as h.f. insulating materials.

It is to be remembered that besides low loss, the insulating materials used must also have sufficient mechanical strength and, when used for such purposes as bases of high power valves—where there is heating due to unavoidable high frequency loss—the temperature rise must not soften the material. Also, since high frequency equipments like radio apparatus are now used under extreme climatic conditions, the insulating materials employed must be able to withstand large variations of temperature and humidity and be resistant to corrosion and other chemical changes. In our investigations only the high frequency loss was studied partly because it is the most important special property of the insulating materials and partly because it was not possible to obtain from the manufacturers materials of suitable shapes and sizes for other tests.

Method and Theory of Measurement of High Frequency Loss

The principle of the measurement was to use the test material (in the form of a plate or thin hollow cylinder) as the dielectric of a condenser and to determine the power factor of the condenser so formed at different frequencies. The dielectric loss could be deduced from the value of the measured power factor. The power factor was measured with the help of a Q'meter.

In a perfect condenser, the voltage lags behind the current by 90°. But due to imperfection of the dielectric used in the condenser, there is always some energy loss in it and the phase difference between the current and the voltage is different from 90°. If the phase angle be θ then the power factor of the condenser is given by $\cos\theta$.

Now an imperfect condenser may be regarded as made up of a perfect condenser (having approximately the same capacity as that of the imperfect condenser) with a resistance in series or in shunt, the losses in which represent the losses in the imperfect condenser.

Regarding the resistance as in series, the power factor of the imperfect condenser is given by

$\cos\theta = p.c.r.$ where p=the angular frequency of operation, c=the condenser capacity, and r=the series resistance.

Regarding the resistance to be in shunt, the power factor is given by

$$\text{Cos } \theta = \frac{1}{\text{p.c.R}_s}$$

where R_S is the shunt resistance.

Hence,

$$\text{Cos } \theta = \text{p.c.r.} = \frac{1}{\text{p.c.R}_s} \quad \ldots \quad \ldots \quad (1)$$

$$\text{or, } R_s = \frac{1}{p^2c^2r} \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

$$\text{and } r = \frac{1}{p^2c^2R} \quad \ldots \quad \ldots \quad \ldots \quad (2a)$$

Now consider a tuned circuit made up of an inductance L, a perfect condenser of variable capacity and a resistance R in series to represent the losses in the inductance (Fig. 1). The magnification of this circuit (LRC_1) is given by

$$Q_1 = \frac{pL}{R} = \frac{1}{pC_1R} \quad \ldots \quad \ldots \quad \ldots \quad 3$$

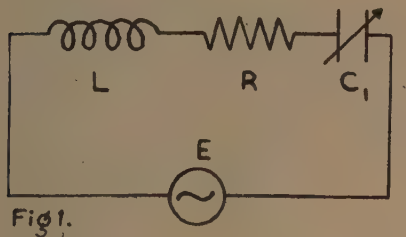


Fig 1.

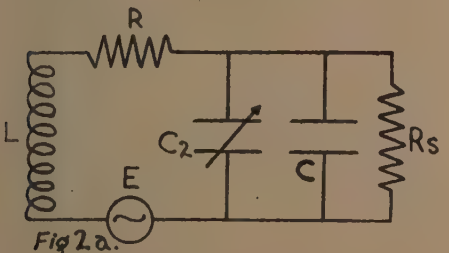


Fig 2a.

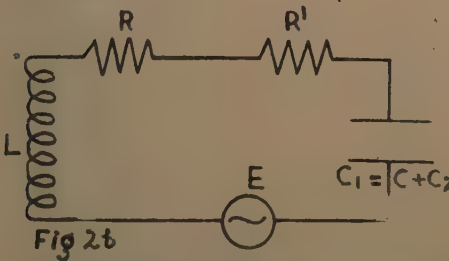


Fig 2b

Now suppose that a condenser with the test material as dielectric is placed in parallel with the capacity C_1 and the circuit is tuned again by varying the value of the tuning condenser from C_1 to C_2. There will be a drop in Q of the circuit due to the loss in the dielectric of the test condenser. This loss may be represented by a resistance R, in parallel with the condenser as shown in Fig. 2*a*. The circuit 2(*a*) is equivalent to the circuit 2(*b*), where $(R+R^1)$ is the equivalent series resistance of the system.

The magnification of the circuit (Fig. 2*b*) is given by

$$Q_2 = \frac{pL}{R+R^1} = \frac{1}{pC_1(R+R^1)} \quad \ldots \quad \ldots \quad (4)$$

From (3) and (4)

$$\frac{1}{Q_2} - \frac{1}{Q_1} = pC_1R^1 = \frac{1}{\text{p.C}_1\text{R}_s} \text{ from (1)}$$

$$\text{or, } R_s = \frac{1}{pC_1} \cdot \frac{Q_1Q_2}{Q_1 - Q_2} \quad \ldots \quad \ldots \quad (5)$$

(It is assumed that the adjustable condenser C_1 is perfect, i.e., its losses are negligible in comparison with the loss in the experimental condenser C with the dielectric under test.) The power factor of the imperfect condenser C is thus given by,

$$\frac{1}{\text{p.C.R}_s} = \frac{C_1}{C} \cdot \frac{Q_1 - Q_2}{Q_1Q_2} = \frac{C_1}{C_1 - C_2} \cdot \frac{Q_1 - Q_2}{Q_1Q_2} \quad (6)$$

Experimental

The Test Condenser.—The materials are generally available in the form of sheets. It was, therefore, necessary to prepare a suitable condenser in which the sheets could be used as a dielectric. A simple form of the condenser is shown in Fig. 3, which is self-explanatory. This condenser, however, suffers from the following defects due to which errors are introduced :

(i) The cross bar at the top forms a capacity with the lower plate.

(ii) The condenser plates do not make perfect contact with the surface of the test material and some air film always remains.

To avoid these, a condenser with mercury electrodes was constructed. This is shown in Fig. 4. The vessel T, made of porcelain, contained mercury on which the test material was allowed to float. A flat brass cylinder was placed on the upper surface of the material and the hollow within the cylinder filled with mercury. Due to its large surface tension the mercury did not leak out. Thus the error due to the cross bar was eliminated and perfect contact was also ensured.

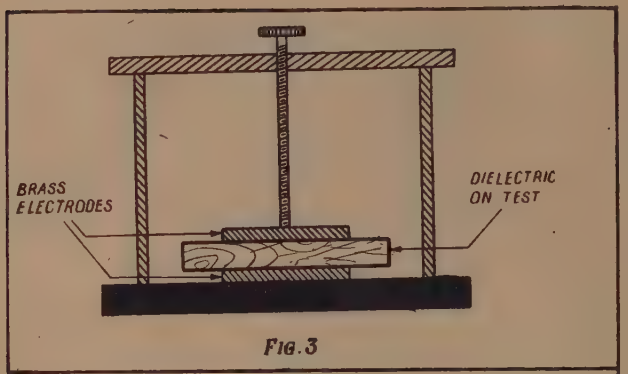


FIG. 3

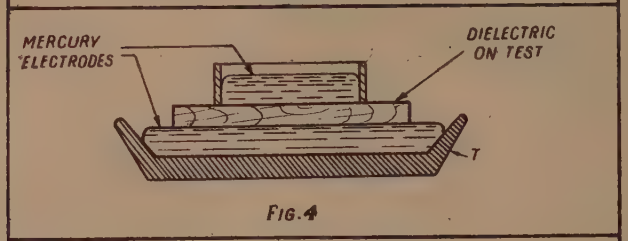


FIG. 4

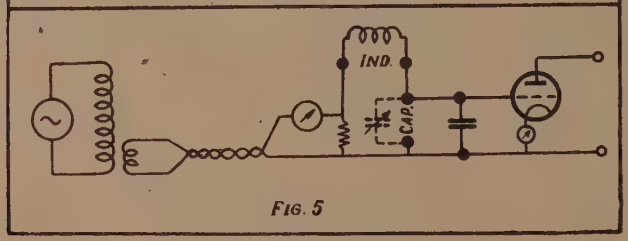


FIG. 5

In some cases the test material was available only in the form of hollow cylinders. In such cases also mercury electrodes were used with obvious modifications.

The experimental arrangement for measuring the Q with the Q-meter is shown in Fig. 5. It will be seen that the Q'meter has three principal parts :

(i) the power unit for supplying the high frequency power (left),

(ii) the tuning circuit in which the test condenser (or inductance) can be introduced (centre), and

(iii) the valve voltmeter (right).

The h.f. energy is led to the tuning circuit by a small coil coupled to the power unit and the current measured by a thermo-ammeter. The voltage developed across the tuning condenser is read by the valve voltmeter. In the instrument used, the range of frequency was from 50 kc/s to 50 mc/s.

TABLE I

Material tested	Frequency range	Power factor variation
1. 50S11CP 135-95 plate (supplied by the D.S.I.R.)	1 mc/s. to 10 mc/s.	0.068 to 0.047
2. V50S11CC 130-95 plate (supplied by the D.S.I.R.) ..	,,	0.159 to 0.073
3. V50S11CC 115-95 plate (supplied by the D.S.I.R.) ..	,,	0.112 to 0.074
4. Paxoline cylinder (Foreign make)	,,	0.025 to 0.029
5. Porcelain (supplied by the Government Porcelain Factory, Bangalore).	,,	0.0047 to 0.010 with minimum at 5 mc/s.
6. Bakelite (supplied by the Government Electric Factory, Bangalore).	,,	0.036 to 0.050 with minimum at 4 mc/s.
7. Shellac moulded board (supplied by the Indian Lac Research Institute).	,,	0.036 to 0.044 with minimum at 2 mc/s.
8. Shellac moulded paper board (supplied by the Indian Lac Research Institute).	,,	0.037 to 0.040 with minimum at 3 mc/s.

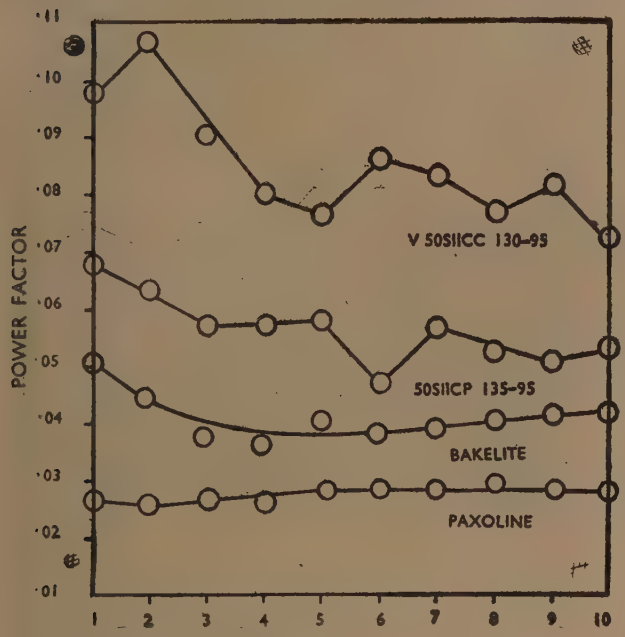


Fig. 6.—Frequency in Megacycles

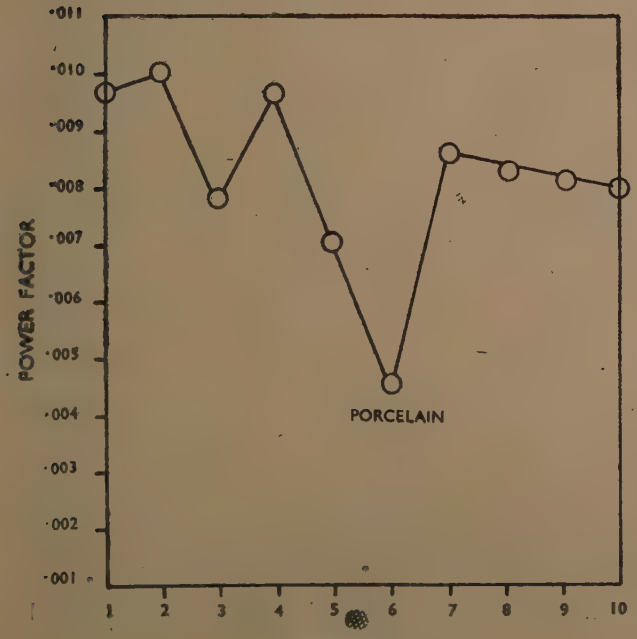


Fig. 7.—Frequency in Megacycles

The procedure for taking a measurement was as follows: At first a coil with fairly high Q is placed in the inductor position and is tuned to resonance by varying the Q' meter condenser (shown dotted) and the value of Q_1 and C_1 noted. Next the condenser C with the test material is connected across the capacitor terminals and resonance again restored by decreasing C_1 to C_2. Due to radio frequency power loss in the imperfect test material, a drop in Q is recorded. The new value of Q, i.e., Q_2, and C_2, are read. From those values of Q_1, Q_2 and C_1, C_2, the value of the power factor is found out with the help of equation (6).

Measurements were made on different frequencies ranging from 1 mc/s to 10 mc/s.

Results

The results obtained with different materials are given in Table I.

The variation of power factor of the materials listed above within the frequency range tested is shown by the curves in Figs. 6, 7 and 8.

Discussion

From the above results it will be seen that three or four types of locally produced materials (porcelain, bakelite, shellac moulded board and shellac moulded paper boards) may be said to have fairly good dielectric properties, compared to imported materials, so far as h.f. loss is concerned. As such, they may be used in the manufacture of radio apparatus. The properties of the materials studied are discussed below individually.

Plastic materials supplied by the D.S.I.R. (items 1, 2 and 3 in Table I)—The power

factors of these materials are rather high compared to those of the imported h.f. insulating material, Paxoline (item 4 in the Table). The materials are mechanically strong, but due to the large loss are unsuited as insulators in h.f. apparatus.

Porcelain.—The power factor of the porcelains produced locally is fairly low (0.0071—0.01) and is comparable to that of the imported materials.

In recent years special types of ceramics which are very stable mechanically, have been developed for use in radio industry. The new ceramic materials developed may be divided into two groups—one of them is the *steatite* group in which the principal constituent is magnesium silicate and the other is the *rutile* group, in which the main constituent is rutile, a form of titanium dioxide. The steatite group has great mechanical stability and low dielectric loss, while the rutile group has high dielectric constant. These materials are now used in the manufacture of transmitting condensers, coil formers, etc. It is desirable that investigations be carried out in this country for the production of these special types of high frequency ceramics.

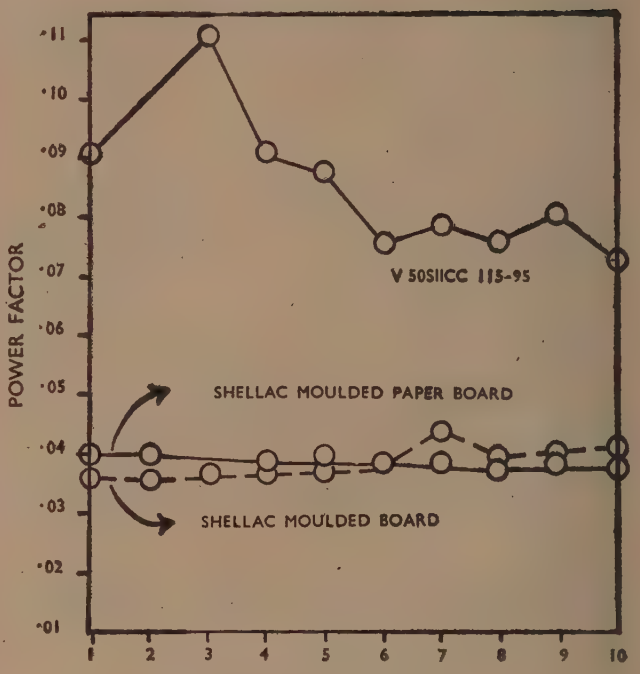


Fig. 8.—Frequency in Megacycles

For our tests, as already mentioned, we were able to procure only ordinary porcelain from the local manufacturing concerns. The results of our test (h.f. loss) are given in Table I.

Bakelite.—The power factor (0.036 to 0.050) is comparable to that of the foreign products (e.g., Paxoline). Moulding facilities are not known. The specimens tested were a little brittle but they may be used as insulating bases and also as coil formers.

Shellac Moulded Boards.—The power factor (0.036 to 0.044) is comparable to that of bakelite. The material is very hard and it is very difficult to cut it into suitable sizes and shapes. This limits its uses. We are not certain if the material can be used in making coil formers. For testing this material, we asked the *Indian Lac Research Institute, Ranchi*, to supply us with the material in the form of tubes. But unfortunately they were unable to comply with our request, due to lack of necessary equipment for moulding tubes.

Shellac Moulded Paper Boards.—The power factor (0.037 to 0.040) is comparable to that of bakelite and of shellac moulded boards. The material has got the advantage that it is unbreakable. This property makes it suitable for radio frequency coil formers although it is not very stable mechanically.

As mentioned before, the survey of the h.f. properties of insulating materials, as made in India and presented in this paper, is not at all complete. Other properties such as mechanical strength, the reactions to moisture and the yielding temperature, that is the temperature at which the material begins to soften and yield mechanically, have to be studied systematically in order to make the survey complete.

The work was carried out under the direction of Prof. S.K. Mitra and Dr. H. Rakshit to whom the author is greatly indebted.

STUDIES ON INDUSTRIAL ENZYMES

PART I—A COMPARATIVE STUDY OF THE BRANS, THE HUSKS AND THE OIL CAKES AS RAW MATERIALS FOR THE PRODUCTION OF DIASTASE

By A. N. BINDAL AND M. SREENIVASAYA

(*Indian Institute of Science, Bangalore*)

ENZYMES are extensively distributed in nature; they occur in abundance both in the vegetable and the animal kingdoms; they are intimately associated with the living cell from which most of them can be easily extracted with the aid of suitable solvents[1-12].

Enzymes find wide and extensive employment; in scientific investigation[13-16] and clinical practice as reagents[17], in medicine as physiologically active drugs, in industry as biochemical catalysts which promote liquefactions, saccharifications and other types of hydrolytic degradations[18-31].

TABLE I

Industrial and Scientific Applications of Enzymes

Enzymes	Source	Industry	Applications
Diastases	Bacterial, fungal, pancreatic and malt.	Brewing, food, textile and pharmaceutical industries.	(1) Liquefaction of unmalted cereals and for the production of worts of low fermentability[20]. (2) For dextrinising and solubilizing cocoa starch in the preparation of chocolate syrups. (3) For the removal of starch in the preparation of pectin from apples. (4) For the saccharification of starch associated with apples, bananas, etc., in the preparation of fruit syrups. (5) Desizing of textile fabrics. (6) For the preparation of sizing pastes for the textile industry. (7) Pharmaceutical purposes.
Invertases	Fungal and yeast.	Confectionery.	(1) Preparation of non-crystallizing syrups of high density and stability.
Proteases	Bacterial, plant and animal.	Food, photographic, leather, rubber and pharmaceutical.	(1) Solubilizing the proteins during the clarification of hazy beers. (2) Dissolution of gelatin of photographic films to facilitate the recovery of silver. (3) For the preparation of protein-free rubber. (4) For the bating of hides and skins. (5) For the stepwise degradation of proteins in the preparation of various grades of peptones. (6) Pharmaceutical purposes.
Pectinase	Fungal.	Food.	(1) For the clarification of fruit juices, (2) To facilitate the recovery of acids. sugars and other constituents associated with fruits.
Urease	Bacterial, soya-beans and horse-gram.	Scientific Research.	As a laboratory reagent for the estimation of urea in physiological fluids.
Arginase	Fungal and liver.	Do.	As a laboratory reagent in the estimation of arginine.

In some of the industries, enzymes play an indispensable role; the reactions which they potentiate cannot be accomplished by other agents with the same ease, rapidity, specificity and elegance, which generally characterize all enzymatic reactions. The desizing of textiles, the saccharification of starch, the clarification of fruit juices, the bating of skins and the stepwise degradation of proteins, represent some of the industrially important processes, which are best carried out through the agency of specific enzymes. Table I gives some of the more important industrial applications of enzymes.

Enzymes for industry are derived from some of the richest sources which include micro-organisms, germinated seeds like malt, vegetating parts of certain species of plants, exudates of certain types of fruits like papain and the organs of slaughtered animals, like the pancreas[3]. It is strange that sufficient attention has not been paid to the marine fauna as a source of industrial enzymes but it may be predicted safely that it would prove one of the rich and inexhaustible sources of enzymes.

Manufacture of enzymes from micro-biological sources, possesses the exceptional advantage that within certain limits[19] the production can be strictly controlled; the enzyme content of the micro-organisms can be enriched at will by a suitable alteration in the environmental conditions of growth. The micro-organisms for the purpose can be cultured on an intensive scale and in unlimited quantities. A large variety of organisms—bacteria, fungi and yeasts—are available; many of them can be specifically adapted or conditioned to produce selectively one type of enzyme in a preponderating proportion to the practical exclusion of other types; the thermostability and other physical properties of a given preparation can be modified to suit special requirements[30]. For example, a bacterial diastase functioning at a temperature of 60 or 70° C. can be obtained by a gradual adaptation of *B. mesentricus*, or certain strains of *B. subtlis* to progressively higher temperatures.

Table II gives the pH. and temperature optima and the ratio of the α to the β components of the diastase complex for amylases from some of the important sources. That the formation of adaptative enzymes could be stimulated to a substantial degree in micro-organisms by appropriate treatment is a circumstance which is specially characteristic of micro-organisms.

The Council of Scientific and Industrial Research have sponsored a scheme for the collection and preservation of a National Collection of Type Cultures for India. This collection has been of inestimable value in providing the necessary micro-organisms for the study of industrial enzymes.

A great impetus to the study of industrial enzymes of microbiological origin has been given by the generous grant of a scheme on industrial enzymes by the *Council*. The results described in this series of papers are the outcome of investigations conducted under the scheme.

Historical Review

The production of diastases from micro-biological sources has formed the subject of numerous investigations. In 1887 Fitz studied the schiozomycetes fermentation of starch and dextrins. In 1881 Atkin described the process of *sâke* manufacture in Japan where *A. oryzæ* was employed as the saccharifying agent. In 1882 Wortman isolated enzymes from a crude culture of *B. termo*, which was found to hydrolyse starch. In 1887, Nageli demonstrated the production of diastase from a number of bacteria and a more detailed and comprehensive study of bacterial diastases was conducted by Fermi in

TABLE II

Different Types of Amylases

Source	Optm. pH.	Optm. Temperature °C.	Ratio α : β
Pancreatic	7.0	35	2 : 1
Malt	4.4–4.5	54—56	2 : 1
Fungus (*A. oryzæ*)	α, 3.0	40	7 : 1 to 9 : 1
" "	β, 4.8	55—60	...
Bacterial	7.0–8.5	75—80	Mostly α

1890. During the period 1894-1914, Takamine published his classical researches on the production of fungus diastase; in 1914, he took a number of patents for the large-scale manufacture of what is generally known as Taka diastase, using *A. oryzæ* as the micro-organism[33-36]. He employed his preparations for the saccharification of cereals. In 1898, Biodin developed the Amylo Process for the saccharification of starch employing *Amylomyces Rouxii, mucors* and *Rhizopus delemar*. Effront found that in the amylo process, enzymes derived from *B. mesentricus* gave far better results than those obtained by the employment of fungal enzymes. He has taken a number of patents for the preparation and use of bacterial enzymes[37,38]. The present contribution relates to a study of some of the farm and industrial by-products as raw materials for the production of diastase by employing *A. oryzæ* as the micro-organism.

Raw Materials for the Production of Diastase

Previous investigators have employed brans, oilcakes, fish meal, corn meal, crushed soya-bean, yeast and other products, either as exclusive substrates or as supplements to a basal medium. Of the materials so far investigated, wheat bran has been found to be the substrate *par excellence* for the growth of *Aspergillus oryzæ*[39].

An ideal substrate for enzyme production is one which will promote the vegetative growth of *A. oryzæ* in abundance and of a quality which will be rich in its diastase content. The medium should not encourage the early formation of spores. Additions of yeast extract, for example, have been found to induce early sporulation of the fungus and to reduce the diastase content.

The raw materials which may be found suitable for the production of diastase fall broadly into two groups :

(i) the brans, the oilcakes and the slaughter-house offals which could be utilized either as cattle fodder or as poultry feed, and

(ii) those which have no fodder but only a fuel (e.g., groundnut husk) or a manurial value (e.g., castor or mohua oil cake).

The latter group of materials are available in considerable quantities in the country and a study of their suitability as diastase-producing substrates is of great importance.

Materials and Methods

The following raw materials have been taken up for investigation :—

(1) Ragi *bhoosa*—the fine husk which separates during the threshing and the winnowing of the grain,

(2) Rice husk—the outer covering of the paddy which separates during hulling,

(3) Groundnut husk—the outer shell of the groundnut which separates during decorticating,

(4) Wheat bran—the broken coat of the grain which is separated during the sifting,

TABLE III

	Wheat	Groundnut husk	Ragi *bhoosa*	Rice husk	Groundnut cake (treated)
	Percentages on the moisture-free material				
1. Moisture	12.80	7.12	4.86	5.85	4.15
2. Ash	5.74	6.23	21.56 (mostly silica)	28.89 (mostly silica)	5.10
3. Ether extract	1.89	1.03	4.20	1.07	0.29
4. 95% Alcohol ext.	1.63	12.14	1.64	0.59	1.50
5. 70% " "	4.80	15.82	6.31	2.81	12.11
6. Water extract	12.82	8.61	11.41	2.45	25.77
7. Reducing sugars in water extract.	1.41	1.40	1.19	0.12	0.76
8. Total nitrogen	2.44	1.99	1.18	0.49	10.02
9. Calcium as Ca	0.23	0.80	1.24	0.36	0.22
10. Total phosphorus as P.	1.04	0.15	0.73	0.10	1.97
11. Potassium as K.	1.42	1.30	2.11	0.55	1.31

(5) Groundnut oil cake—the cake after the extraction of the oil in an Anderson oil expeller.

The above materials were disintegrated in a Carter's disintegrator to a uniform mesh. In the case of the oilcake, it was extracted with petrol ether (B. P., 60°-80° C.) to remove the residual oil. The materials have been subjected to a proximate analysis adopting the methods described in A.O.A.C. The results which are calculated as percentages of the moisture-free material, are given in Table III.

Measurement of Diastatic Activity

The estimation of the diastatic activity was carried out by the method developed by Gore and Steele who have correlated Lintner's scale with the amount of maltose released during the diastasis of starch under well defined conditions of experiment[40].

A malt is given a diastatic activity of 100 on the Lintner's Scale, when 0.1 c.c. of a 5 per cent. filtered extract acting on 2 per cent. soluble starch buffered to a pH. of 4.6 with acetate buffer at 21° C. for 1 hour, reduces 5 c.c. of Fehling solution. In other words, 1 c.c. of a standard infusion of malt of 100 Lintner units should produce sufficient reducing substances, reckoned as maltose hydrate, completely to reduce 50 c.c. of Fehling solution, the conditions of hydrolysis remaining as above[40].

Since 50 c.c. of Fehling solution corresponds to 493.1 mgms. of Cu_2O, it becomes equivalent to 408.3 mgms. of maltose hydrate. It, therefore, follows that reducing substances consisting largely of maltose, equivalent in reducing power to 408.3 mgms. of maltose hydrate are formed under standard conditions specified above, by 50 mgms. of malt possessing 100 Lintner units. If we accept Kjeldahl's law of proportionality as operative during the reaction, the relation of the Lintner value (L) to the amount of reducing substances reckoned as maltose hydrate, may be expressed by the following formula :—

$$L = \frac{100\ M}{408.3}$$

where L is the diastatic activity expressed in Lintner units and M is the amount (in milligrams) of maltose hydrate experimentally determined. Lintner's values are determined at 21° C. but this temperature does not represent the optimum for diastases of fungal origin. The optimum temperature for taka diastase is 40° C. Since we are primarily concerned with a determination of the maximum enzymatic activity capable of being exhibited by a given preparation of diastase, the optimum conditions of temperature, and reaction characterizing the preparation will have to be maintained. We have, therefore, conducted all determinations of diastase activity at a temperature of 40° C. and at a pH. of 4.8. The reducing substances have been estimated by the micro method of Schaffer and Hartmann and the results calculated as maltose hydrate[41]. The values of maltose hydrate are converted into Lintner units at 40° C. by the above formulæ.

The total solids in the enzyme extract are determined separately by drying a given volume (5 c.c.) in a desiccator and weighing the residue to constant weight. The diastatic activity is expressed in Lintner units per 50 mgms. of the total solids in the extract. The total number of Lintner units obtained from 100 gms. of the raw material is also calculated.

Selection of the Strain of *Aspergillus oryzae*

The strain of *Aspergillus oryzæ* employed in these investigations was selected after a careful and comparative study of the diastase-producing capacity of the several type cultures obtained from the National Collection. They were grown under comparable conditions and the diastatic activity of the extracts prepared from the mouldy brans determined. The results are given in Table IV.

TABLE IV

Strain No.	Activity in Lintner units	Activity per gram in L.U. (determined at 40° C.)	Total solids per 100 gms. of the raw materials.	Total number of units per 100 gms. of the raw materials.
N.C.T.C. 546	610	12,200	10.0	122,000
„ 547	367	7,340	10.2	74,868
„ 548	70	1,400	10.4	14,560
„ 558	800	16,000	9.4	150,400

It will be seen that N.C.T.C. No. 558 was found to represent the most potent strain so far investigated. This culture has been adopted in the entire course of our studies.

Experimental

A weighed quantity of the raw material (10 gms.) was transferred into a 250 c.c. conical flask, supplemented with graded amounts of groundnut cake (0.5 and 1.0 gm.), 15 c.c. of water added and then intimately mixed. The substrate was then autoclaved at 20 lbs. for 30 minutes.

The inoculation was carried out with the spores of the fungus grown on malt agar for about 12-15 days at 30° C.

The reaction mixtures after inoculation were incubated at 30° C. for 4 days ; mixing of the mass was carried out at intervals during the period of incubation.

The mouldy mixture was then subjected to autolysis by grinding up the mass with toluene-saturated water (50 c.c.) for 4 hours at the room temperature (25°-27° C.). The mixture was filtered and the clear solution was employed for the estimation of the diastatic activity. The extract thus prepared measures about 50 c.c.

The results are given in Table V.

Discussion, Summary and Conclusions

It will be seen from Table V, that—

(1) Wheat bran gives a preparation of diastase possessing the highest activity per gram of the preparation ; the yield as measured by the total number of units is also high.

(2) The rice husk when supplemented with about 10 per cent. groundnut cake, gives a preparation whose purity is very nearly equal to that possessed by the wheat bran preparation ; but the yield is only a third of the quantity obtainable from wheat bran under comparable conditions.

(3) The steady increase in the yield of diastase with increasing additions of groundnut cake to the rice husk, suggests the possibility of obtaining still higher yields of diastase by supplementing the substrate with further additions of the groundnut cake. A 10 per cent. addition of the cake has brought about a fourfold increase in the yield of diastase, without sacrificing the purity of the preparation.

(4) The results obtained with Ragi *bhoosa*, are not encouraging. The quality of the preparation is very poor and the yields are not satisfactory.

(5) Experiments with groundnut husk are promising. The yield of diastase, as measured by the total number of units, is very appreciable, more especially, when the husk is supplemented with groundnut cake. But the purity of the preparations is not so high as that characterizing the preparations from either bran or rice husk.

TABLE V

	Activity in Lintner units (at 40° C. per 50 mgms. of the preparation)	Activity per gm.	Total solids per 100 gms. of the raw material	Total units per 100 gms. of the raw material
Wheat bran alone	840	16,800	9.20	154,560
Wheat bran +0.5 gms. of groundnut cake	884	17,680	11.0	194,480
Wheat bran +1 gm. of G.N.C. ..	860	17,200	14.0	240,800
Rice-husk alone	510	10,200	1.97	20,094
Do. +0.5 gm. G.N.C. ..	802	16,040	2.85	45,714
Do. +1.0 gm. „ ..	840	16,800	4.57	76,776
Ragi *bhoosa*	95	1,900	9.05	17,195
Do. +0.5 gm. G.N.C. ..	180	3,600	10.00	36,000
Do. +1.0 gm. „ ..	203	4,060	10.10	41,006
Groundnut husk	470	9,400	4.17	39,198
Do. +0.5 gm. G.N.C.	556	11,120	5.98	66,497
Do. +1.0 gm. „	540	10,800	8.60	92,880

G.N.C.=Groundnut cake

(6) The results point to the possibility of improving, to a considerable extent, the yield of diastase by further additions of groundnut cake, both in the case of rice and groundnut husks.

(7) The exceptional diastase producing capacity of the wheat bran, as compared with that of the other raw materials, is striking. A detailed investigation of the factors favouring the production of diastase with special reference to the wheat bran is in progress.

(8) The present studies have established the possibility of employing the rice and groundnut husks as raw materials for the commercial production of diastase, when they are supplemented, with groundnut cake to the extent of 10 per cent.

Our grateful thanks are due to the *Council of Scientific and Industrial Research* for their generous grant for the study of industrial enzymes. Our thanks are also due to Mr. B. N. Sastri, Editor, *Journal of Scientific and Industrial Research*, who has been closely associated with this work, for many fruitful suggestions and to Sir J. C. Ghosh, for the keen interest he has evinced in these investigations.

References

1 Euler, Hans Von., *General Chemistry of Enzymes*, 1st Edn., 1912.
2 Tauber, Henry, *Enzyme Chemistry*, New York, John Wiley and Sons.
3 Waksman, S.A., *Enzymes—Properties, Distribution, Methods, Applications*, 1922.
4 Davison, W. C., and Waksman, S. A., *Bacteriological Abstracts*, 1922, **6**, 265.
5 Fulmer, E. I., and Buchnan, R. E., *Physiology and Biochemistry of Bacteria*, 1928-30.
6 Haldane, J. B. S., *Enzymes*, 1930.
7 Bayliss, W. M., *Nature of Enzyme Action*, 5th Edn., 1925.
8 Nord, *Recent advances in Enzymology*, 1943.
9 Hasse, A., *Enzymat Technologie der Garungs Industrien*, Leipzig, 1929.
10 Hasse, A., *Ergebnisse Der Enzymforschung*, III & IV Band.
11 Bergman, Max, *Harvey Lectures*, Vol. 31 p. 37, Baltimore, Williams and Wilkins, 1936.
12 Effront Jean, *Biochemical Catalysts in Life and Industry*, 1st Edn., 1917.
13 Davish and Daish, *J. Agr. Sci.*, 1916, **10**, 3, 56 ; 1914, **6**, 152.
14 Hanes, C. S., *Biochem.J.*, 1936, **30**, 168.
15 William A. Davis, *J. Soc. Chem. Ind.*, 1916, **35**, 201.
16 Balch and Phillips, *Ind. Eng. Chem., Anal. Edn.*, 1941, **13**, 815.
17 Myers V. C. and Free A. H., *Amer. J. Clin. Path.*, 1943, **13**, 42.
18 William, J. J., *Report, of the Proceedings of the 3rd International Congress of Microbiology*, 1939, 743 (1940).
19 Effront and Jean, *Chimie and Industrie*, 1940, **43**, 3-12.
20 Wallerstein, Leo, *Ind. Eng. Chem.*, 1939, **31**, 1218.
21 Wallerstein, Leo, *Science of practical Brewing*, 1939, No. 7, 5-20.
22 Wallerstein, Leo, *American Brew*, 1938, **10**, 38.
23 Wallerstein, Leo, *Ukraine Biochem. J.*, 1939, **13**, 185.
24 Owen, W. L., *Ind. Eng. Chem.*, 1933, **25**, 87.
25 Ernst R. C., Brown, C. F. and Tepe J. B., *Ind. Eng. Chem.*, 1939, **31**, 1247.
26 Underkofler, L. A., Fulmer, E. I. and Schoene L., *Ind. Eng. Chem.*, 1939, **31**, 734.
27 Underkofler, L. A., *Production of Diastatic material*, U. S. Patent No. 2,291,009; *British Chem. Abst.*, 1943, B. 3, 243.
28 Hao, L. C., *British Chem. Abstr.*, 1943, **B. 3**, 243.
29 Plevako, E. A. and Chelen, M. E., *C. A.*, 1942, **36**, 7226.
30 Leopold & Puka, *Zentr. Bakt. Par.*, 1938, **2**, 97, 353.
31 Feniksova, R. E. Segal, R. B., *Biol. Abstr.*, 1943, 11855.
32 Yudkin J., *Biol. Rev.*, 1938, **13**, 93.
33 Takamine, J. *Soc. Chem. Ind.*, 1898, **17**, 118
34 Takamine, J., *Country Brewers*, 1894.
35 Takamine, J., *Indus. Eng. Chem.*, 1914, **6**, 824.
36 Takamine, J., *Chemical News*, 1914, **109**, 215.
37 Biodin, Auguste, and Effront, *U. S. Patent*, 1,227,525.
38 Biodin, Auguste, and Effront, *U. S. Patent*, 1,227,374.
39 Oshima, K. and Church M. B., *Ind. Eng. Chem.*, 1923, **15**, 67.
40 Gore, H. C. and Steele, H. K., *Ind. Eng. Chem., Anal. Edn.*, 1935, **7**, 324.
41 Stiles H. R., Peterson, W. H. and Fred, E. B., *J. Bact.*, 1926, **12**, 426.

POWER ALCOHOL INDUSTRY

"THE question of the development of Power Alcohol industry was under Government's consideration," said Sir Aziz-ul-Haque, Commerce Member, in reply to Mr. K. C. Neogy, on 16th November in the Central Assembly. He added that there were at present four alcohol plants in operation in India, and their total capacity was estimated at between $1\frac{3}{4}$ and $2\frac{1}{2}$ million gallons per year. Orders for power alcohol plants were placed in September 1937 in America; but the plants had not as yet been released by the American authorities. If they materialized they would be allotted to the firms which originally placed orders.

J. K. CHEMICALS AND PHARMACEUTICALS CO.

Applications are invited for the following posts :—

1. Two superior posts on Rs. 2,000—3,000, and Rs. 1,500—2,000 respectively. Applicants must possess very high academic qualifications in chemistry or/and chemical engineering with wide manufacturing and administrative experience. Applicants must be capable of drawing up plans for a first-rate pharmaceutical unit for the production of fine chemicals and other pharmaceutical products, and in a position to implement their proposals.

2. Heads for the following sections :— Inorganic, Organic, Biochemical, Pharmaceutical, Cosmetics and toilet articles, on Rs. 500—1,500 (initial salary according to qualifications). Applicants must be young men with first-rate academic qualifications with specialized and practical experience in particular fields or lines of manufacture, and should possess some factory and research experience.

3. Secretary—Rs. 300—500. Applicants should have good academic qualifications in Science, particularly in chemistry, and possess capacity for sifting scientific material and drafting, and knowledge of office procedure.

Applications, giving full particulars regarding age, academic qualifications, practical experience, present emoluments, research work done, together with copies of research papers, wherever possible, and salary expected, should be marked **"PHARMACEUTICALS" AND SENT TO N. C. MEHTA, DIRECTOR, J. K. INDUSTRIES, KAMLA COTTAGE, JUHU, BOMBAY.**

J. K. CHEMICALS AND PHARMACEUTICALS CO.

Applications are invited for the following posts :—

1. Chief Engineer—Rs. 500—1,500. Applicants should possess a degree in chemical engineering with 3-5 years' practical experience in the design and operation of chemical plants.

2. Workshop Superintendent—Rs. 400—750. Applicants must possess wide practical experience with capacity to design new types of plants and equipment needed.

3. Electrical and Mechanical Engineer—Rs. 400—750. Applicants should possess a good degree in electrical and mechanical engineering and have at least 4 years' experience in the erection and maintenance of chemical plants.

Applications, giving full particulars regarding age, academic qualifications, practical experience, present emoluments, research work done, together with copies of research papers, wherever possible, and salary expected, should be marked **"PHARMACEUTICALS" AND SENT TO N. C. MEHTA, DIRECTOR, J. K. INDUSTRIES, KAMLA COTTAGE, JUHU, BOMBAY.**

FILTER MEDIA FOR FINE FILTERS OF PORTABLE PRODUCER-GAS PLANTS

By LAL C. VERMAN, K. ACHUTHAN NAIR, M. L. KHANNA AND S. K. DAS GUPTA

(*Physical Laboratories, Council of Scientific and Industrial Research, Delhi*)

ONE of the chief causes of wear and tear in automobile engines working on producer gas is the excessive concentration of dust in the gas as finally supplied to the engine. The amount of dust passing to the engine, depends to a large extent, on the design and operating condition of the filters. In a scientific design of the filter system, the first filter should be able to retain the coarser particles of dust, the next less coarse particles, and so on and the final filter must be able to remove the finest particles considered harmful to the engine, without causing undue pressure drop. Rational design of the final filter is considered to be of the utmost importance. Opinion is divided as to the most suitable filter medium for use in the final filters. Some authorities prefer hair felt, others regard some kind of fabric or cloth more desirable. The problem, therefore, was to investigate the various filter media, with a view to arriving at the best material, which will at the same time be reasonably priced and readily available in sufficient quantity. The use of such a material could then be insisted upon by every portable producer plant in the country.

Materials Examined

With this object in view, a search was made for the various representative types of materials likely to serve the purpose and a number of them was collected. Particulars of these are given in Table I.

The first six materials of Table I were thoroughly washed with soap, rinsed several

TABLE I

General Description of Materials Examined.

No.	Kind of material.	Trade Mark.	Place of origin.	Colour.	Weight per sq. ft. lbs.	Width of material in inches	Price per yard. Rs. a.	Visual observations.
1	Satin drill cloth..	R 52	England	White	—	27	3 0	Pin holes visible.
2	Do. ..	PPPPP	Ahmedabad	Do.	—	27	2 8	No holes visible.
3	Do. ..	A 915	Do.	Do.	—	27	*2 8	Pin holes visible.
4	Drill cloth ..	255	Cawnpore	Do.	—	33	1 6	Innumerable pin holes visible.
5	Do. ..	WB017	Madras	Do.	—	33	*1 8	Do. do.
6	Longcloth ..	H7414	India	Do.	—	36	1 0	Sun light freely passes through.
7	Twill cloth ..	Ap. 72	Ahmedabad	Do.	—	30	1 2	Sun rays freely pass through.
8	Pressed wool felt, ¼" thick ..	..	Jaipur	Brown	0.144	24	2 8	Pin holes visible. Material was unevenly packed.
9	Pressed wool felt, ½" thick ..	..	Do.	White	0.322	24	5 0	Impervious to sun rays.
10	Chester Cloth ..	..	English	Black	0.120	54	25 0	Do. do.

* Approximate price.

times in cold water to remove the soap and then dried. This process was carried out twice to ensure complete removal of the sizing material. All the experiments on these materials were carried out after treating them as above. No experiments were considered necessary with new cloth, because, in practice, every piece of filter cloth is washed after the first 100 miles or so of run, and, furthermore, because, new cloth was bound to have smaller pores than the washed ones due to the presence of sizing material. Chester cloth and the two felt samples were used as such, because these are usually cleaned in practice by air blast or brushing, which do not affect their pores, in the same manner as washing affects the texture of cloth.

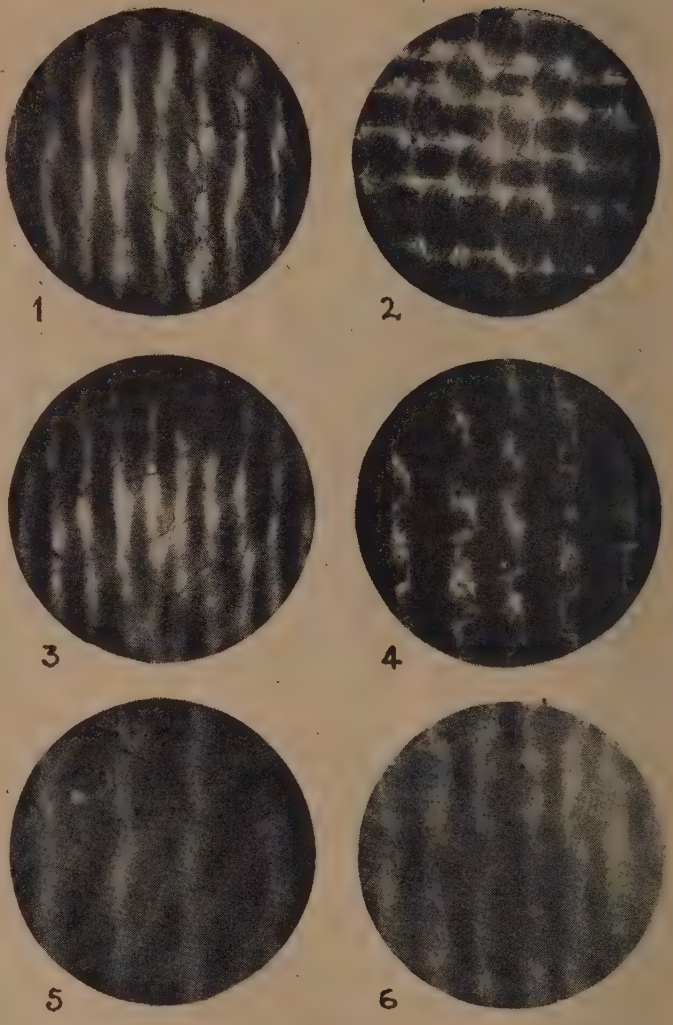


Fig. 1.—Photomicrographs of satin drill cloths × 21; 1. R52 Face ; 2. R52 Back ; 3. PPPPP Face ; 4. PPPPP Back ; 5. A 915 Face ; 6. A 915 Back.

Experimental Procedure

The main requirements of a good filter material are that it should pass the least quantity of only the smallest particles of dust and, at the same time, allow sufficient quantity of gas to pass through a given filtering area, with the minimum of pressure drop. The points to be studied, therefore, are the character of the materials including the size and distribution of the pores and the pressure drop in relation to the flow of gas through the material. The character of various types of woven filter media and also the nature of the flow of gases through porous substances like various kinds of sands, etc., have been studied by other workers[1,2]. But a comprehensive study of the materials, as required in the present case, does not appear to have been carried out so far. The following tests were, therefore, conducted on all the materials.

(1) Visual and microscopic examination.
(2) Pressure drop test.
(3) Pore size test.

The apparatus and equipment used for the investigations were the same as those used for "Standardization of filter papers for gas purity tests[3]," by the same authors.

(1) *Visual and Microscopic Examination.*—The material was held directly against bright sunlight and observed by the naked eye. The results of these observations are summarized in Table I.

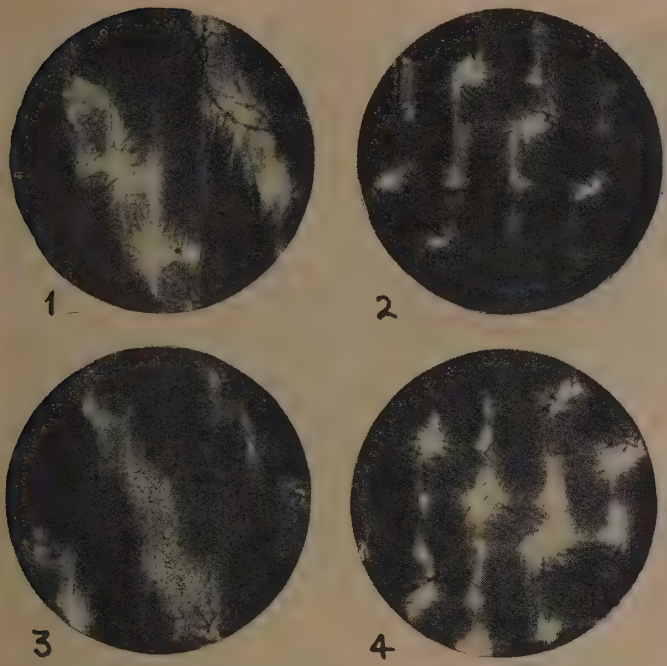


Fig. 2.—Photomicrographs of drill cloth × 21 ; 1. 255 Face ; 2. 255 Back ; 3. WB017 Face ; 4. WB017 Back.

Strips of the material were examined under the microscope by transmitted light, using a magnification of 60. Materials 8, 9 and 10 had to be examined by a much more powerful light than others, because they were impervious to the usual light. Figs. 1, 2 and 3 show a set of typical photomicrographs of the materials. No photographs could be taken of materials Nos. 8, 9 and 10. The pin holes observed during visual examination may be identified in the photograph by the bright spots. However, it is noticed that there are many fine hair-like filaments projecting into these bright patches or pin holes, which play a great part in the initial stage of filtration by arresting relatively large particles and thereby reducing the effective area of the pin holes.

(2) *Pressure Drop Test.*—First, the difference of drop in pressure on the two sides of the filter unit (described in detail elsewhere[3] and shown in Fig. 4), was measured at various rates of flow of air, by a water manometer. Next, each piece of material cut to the required diameter was, in turn, clamped between the two conical funnels in the same manner that a filter paper is clamped for gas purity tests. Air was drawn through the material at various rates and the pressure drop again measured with a water manometer. After testing all the ten materials in this way, a final pressure drop test was made of the filter unit itself as at the beginning. The pressure drop with each material, exclusive of that in the test filter unit, was calculated for various velocities of flow through the material and the results are shown in Figs. 5 and 6 and Table II. The velocity of flow was obtained in feet per minute by dividing the flow of gas in cubic feet per minute by the effective area of the material which was 1.396 sq. feet.

(3) *Pore Size Test.*—Each material was cut to the size of the test filter unit and clamped between the two conical funnels with a close-meshed Whatman paper below it. The cloth and the filter paper were separated by 1/16″ from each other by means of a wire mesh (see Fig. 4). The plant was started and air was drawn through the filter unit at the rate of 35 c. ft. per minute which corresponded to a velocity of 25 ft. per minute through the material which had an effective area of 1.396 sq. ft. This velocity of 25 ft. per minute was found to be the maximum obtaining in practice in most of the existing designs of producer plants. The size of particles of dust passing through the filter material depended to some extent on the velocity of the gas through it. Larger velocities of gas are likely to force apart the fibres of the material and allow bigger particles to pass through. By choosing a velocity of 25 ft. per minute for the tests, the pore size as measured will be the maximum that will obtain in actual practice. Into the stream of air entering the top funnel of the filter through the 2″ pipe, was introduced, at a uniform rate, a finely powdered mixture of charcoal and clay in the proportion of 40 to 60. This proportion was chosen to

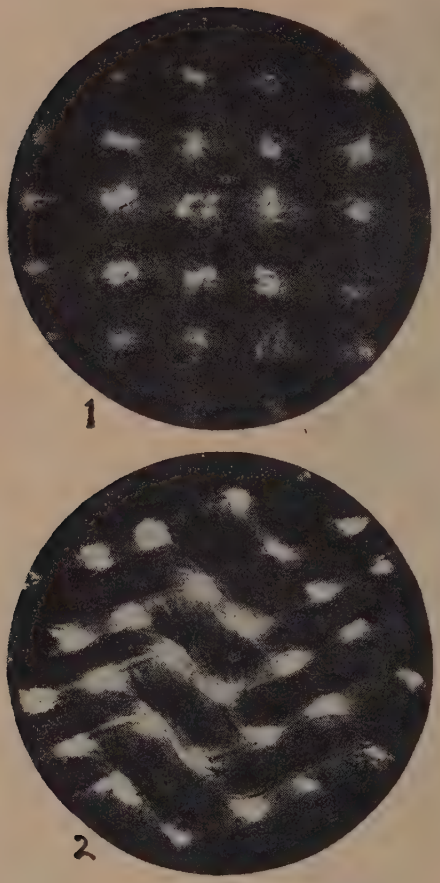


Fig. 3.—Photomicrographs of twill and longcloth × 35. 1. Longcloth, H 7414 ; 2. Twill cloth, AP72.

correspond roughly to a typical sample of dust collected from producer gas that was analysed in these laboratories[4]. The test was normally conducted for 30 minutes, but in the case of some materials such large quantities of dust collected on the bottom Whatman filter paper during this period, as to make it difficult to observe individual particles under the microscope. In such cases, the test was repeated for a shorter period. The Whatman paper which arrested the particles passing through the material under investigation was examined and the maximum predominant size of the dust particles was measured under the microscope. These measurements were taken independently by three observers at a number of points of the paper, the total number of observations for each material being 15 to 30. The mean of these values and the probable error are given in Table III. The magnification used was 252.

Discussion

A study of the photomicrographs (Fig. 3) shows that longcloth and twill have a very open texture, and this is confirmed by the results of dry pore size test (Table III). These two materials must, therefore, be considered as unsuitable for the purpose in spite of their low pressure drops (Fig. 5).

Both of the pressed wool felts, $\frac{1}{4}''$ as well as $\frac{1}{2}''$ thick, have got a large pore size (Table III). In fact the $\frac{1}{2}''$ thick felt gave the largest pore size of all the materials tested. The deposit on the Whatman paper was very dense in the case of the $\frac{1}{4}''$ felt and in the case of the $\frac{1}{2}''$ felt, the deposit was more than that in case of drills and satin drills. It must be concluded that these materials, though they

TABLE II

Pressure Drop Across the Material for various Velocities of Air Flow in inches of Water.

No.	Material	Pressure drop in inches of water for velocities indicated in ft./min.				
		10	20	30	40	45
1	Satin drill R 52	0.21	0.40	0.66	0.94	1.15
2	Do. PPPPP	0.42	0.80	1.26	1.70	2.05
3	Do. A 915	0.25	0.40	0.59	0.84	1.01
4	Drill 255	0.20	0.37	0.58	0.82	1.04
5	Do. WB017	0.34	0.68	1.00	1.40	1.74
6	Longcloth H7414	0.06	0.18	0.32	0.50	0.60
7	Twill AP 72	0.04	0.06	0.07	0.08	0.09
8	Pressed wool felt, $\frac{1}{4}''$ thick ..	0.02	0.03	0.07	0.10	0.10
9	Do. $\frac{1}{2}''$ thick ..	0.11	0.24	0.35	0.46	0.50
10	Chester cloth	0.20	0.38	0.60	0.82	0.93

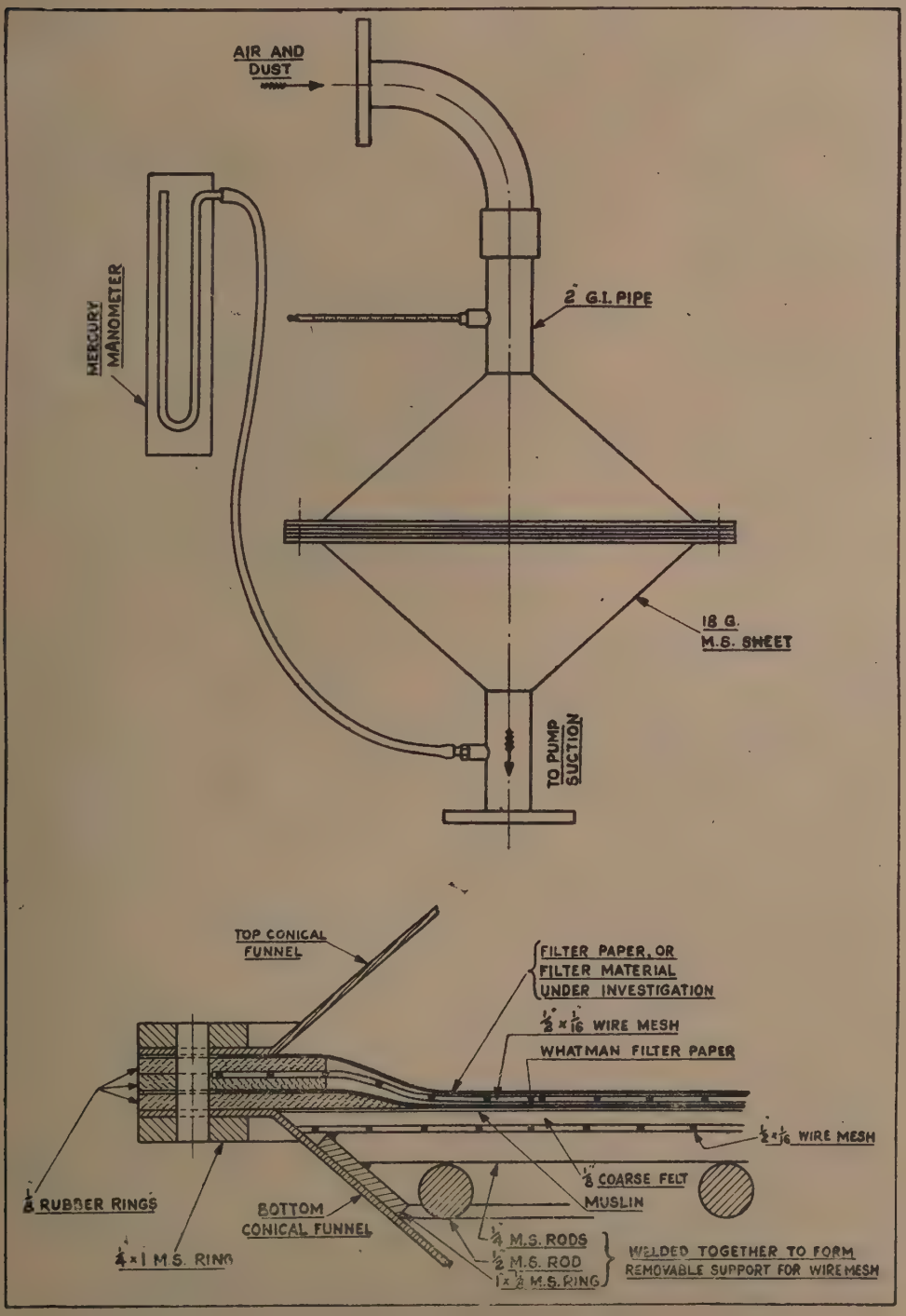


Fig. 4.—Modified Test Filter Unit.

TABLE III

Dry Pore Size Test

No.	Material	Dry pore size μ	Duration of test minutes.	Nature of dust passing through the material and collected on the bottom Whatman paper.
1	Satin Drill R 52	14.9±0.8	30	Very light grey uniform coating of dust.
2	Do. PPPPP ..	16.2±0.8	30	Very light grey uniform coating of dust with slightly darker patches scattered all over.
3	Do. A 915 ..	15.0±0.8	30	Very light grey uniform coating of dust.
4	Drill 255	22.0±0.8	30	Light grey uniform coating of dust with a few dark spots here and there.
5	Do. WB 017	16.4±0.9	30	Light grey coating of dust with many dark patches.
6	Longcloth H 7414 ..	37.5±1.1	30	Thick black coating of dust with many prominent dense spots.
7	Twill AP 72	39.5±1.7	15	Thick black coating of dust with lighter streaks here and there.
8	Pressed wool felt ¼" thick	31.7±0.9	5	Light black uniform coating of dust.
9	Do. ½" thick	41.4±0.9	30	Uniform grey coating of dust.
10	Chester Cloth	25.7±1.5	30	Light grey uniform coating of dust.

give low pressure drop (Fig. 6), are inferior to drills and satin drills. This result is not surprising when it is considered that these felts serve as good heat insulating materials, because of their capacity for enclosing fairly large volume of air in the interstices.

Chester cloth has a larger pore size than drills and satin drills though the pressure drop through it is comparable to one of the drills (Fig. 6). The deposit on the Whatman filter paper is about the same as that in the case of the drills. In any case, this material is too expensive and difficult to obtain and could, therefore, hardly be considered suitable.

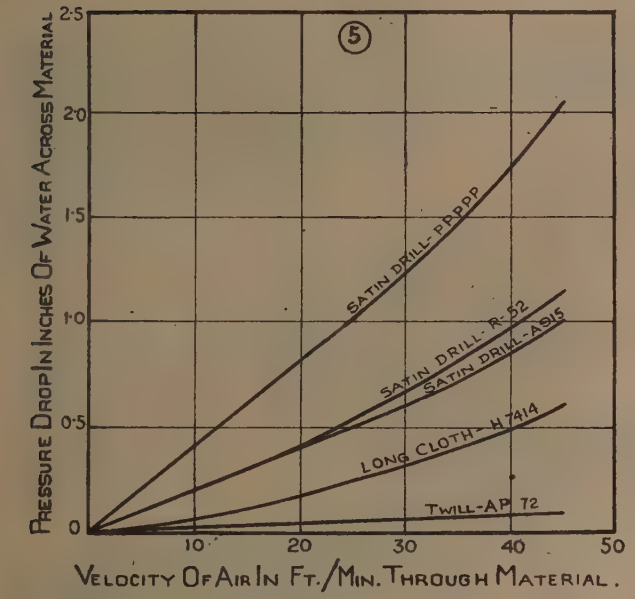
Coming to the drills, it may be noted that Drill WB-017 shows almost as small a pore size (viz., 16.4 μ) as the three samples of satin drills (Table III), while the other drill has a considerably larger pore size (22.0 μ). This is reflected in the pressure drop curves (Fig. 6), the former giving almost about twice as much pressure drop as the latter. The character of the deposit obtained from the former drill, however, shows the presence of a larger number of weak spots than those in the case of satin drills (see last column of Table III). Drill WB-017 may, therefore, serve as a fairly good filter medium, if the excessive pressure drop can be allowed for (which after all is not very difficult) and further, if satin drill of good quality is not available.

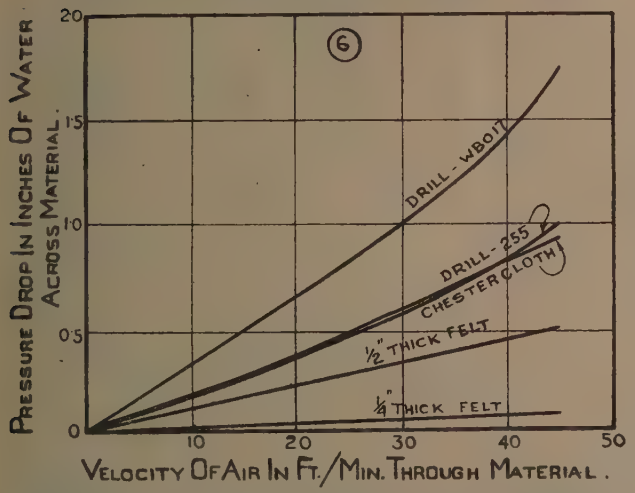
Finally, the three satin drills may be noted to have a uniformly low pore size lying within the small range of 14.9 to 16.2 μ (Table III). In respect of pressure drop (Fig. 5), however, it will be seen that one of three (PPPPP) exhibits about twice as much pressure drop as the other two, the pressure drop in the latter two being about equal to each other. This is a bit surprising at first sight but the behaviour is correlated with the nature of the weave. Satin Drill PPPPP happens to be what is known as Warp-Satin while the other two are what are known as Weft-Satins or Sateens (see following section on specifications). This effect of weave is also reflected in the nature of filter deposit obtained (Table III, last column), showing that warp-satin is more likely to have weak spots, whereas the sateens give a much more uniform filtration.

It is thus concluded that the two samples of satin drill, R-52 and A915, are best suited for producer-gas filtration in respect of pore size, pressure drop and uniformity of filtration.

Specifications

Through the courtesy of the Textile Commissioner, Government of India,





Figs. 5 and 6.—Pressure Drop *vs.* Air-velocity curves; (5) Satin Drills, longcloth and Twill; (6) Drills, Chester cloth and felts.

Bombay, specifications of the three satin drill cloths used for these investigations were obtained. They are given below :—

(1) Satin drill R-52 (mercerized), bleached (weft) manufactured in England. Analysis particulars are :

Combed Egyptian warp 16s, ends per inch 64.

Combed Egyptian weft 44s, picks per inch 240.

(2) Satin drill PPPPP (mercerized), bleached (warp) manufactured in England. Analysis particulars are :

Combed Egyptian warp 30s, ends per inch 200.

Combed Egyptian weft 34s, picks per inch 80.

(3) Satin drill A915, bleached and mercerized, manufactured in Ahmedabad. The quarter particulars are:

Warp 2/40s gassed imported combed Egyptian cotton, ends per inch 80.

Weft 24s gassed imported combed Egyptian cotton, picks per inch 150.

From these analyses, it would appear that a satin drill cloth most suitable for gas filtration should be similar to or closely resemble one of the two samples, R-52 or A 915 both of which are made from mercerized, bleached Egyptian yarn and have predominant number of picks in the weft, i.e., it is woven on the pattern of sateens.

It has been ascertained that this type of cloth is being made and marketed by an Ahmedabad firm, who supplied the sample A 915, and also that other firms in the country are in a position to manufacture similar cloth if required.

Design of Filter

Some considerations entering the design of a final filter are given below, based on the curves of pressure drop in Figs. 5 and 6 :—

It is seen that the curves for pressure drop start deviating from a straight line at about 25 ft./min. velocity of air. It is, therefore, advisable to adopt a velocity not more than 25 ft./min.

Assume, therefore, a velocity .. = 20 ft./min.
For A 915 satin drill the pressure drop at 20 ft./min. .. .. = 0.4″ of H_2O
Maximum permissible value of pressure drop in a producer .. = 5″ of Hg
Assume a pressure drop in the final filter .. .. .. = 1″ of Hg
This would leave pressure drop of 4″ of Hg available for all other parts of the producer plant.

Then, the factor of safety .. = $\frac{1\text{″ of Hg}}{0.4\text{″ of } H_2O}$ = 34

Total flow of gas for a producer fitted to a 30 h.p. vehicle .. = 50 c. ft./min.

Hence required effective area of filter .. .. = 50/20 = 2.5 sq. ft.
Assume diameter of cage on which the cloth is fitted .. = 9″
Then effective length of cage .. = 12.8″
Length of cloth required for one filter .. .. = ½ yd. approx.

References

1 Prior and Walker, *Chem. and Met. Eng.*, 1938 45, 250.
2 Sengupta and Mg. Thein Nyun, *Ind. J. Phys.*, 1943, 17, 39.
3 *J. Sci. & Ind. Res.*, 1944, 3, 203.
4 Lal C. Verman, *J. Sci. and Ind. Res.*, 1944, 2, 259.

Obituary

Dr. E. L. G. CLEGG

BY the death of Dr. E. L. G. Clegg at the age of 50, the *Geological Survey of India* has lost its Director, and the Government of India an officer of outstanding administrative ability.

Dr. Clegg was born at Manchester in 1894, and was educated in the Central High School and in the Victoria University, Manchester. He served through the 1914-18 war as an officer in the Northumberland Fusiliers and saw active service in France and Italy. After the war, he took his M.Sc. from Manchester, and joined the *Geological Survey of India* as an Assistant Superintendent on the 1st December, 1920.

During most of his service he worked in Burma, but from 1926-30 he remained in Calcutta, first as Curator and then as Officer-in-charge of the *Geological Survey Office*. During this period he was also part-time Professor of Geology at the *Presidency College, Calcutta*, and Lecturer in Geology at the *Bengal Engineering College, Sibpur*. He also took a very keen interest in the work of the *Mining, Geological and Metallurgical Institute of India*, being one of its Joint Honorary Secretaries from 1927 to 1930, and its Vice-President in 1943.

In Burma, Dr. Clegg mapped parts of the Minbu and Thayetmyo Districts, publishing a Memoir thereon in 1938 ; while he also studied the Mogok stone tract and made numerous traverses in the defiles of the Irrawaddy, the Jade mines district and elsewhere, the results of this work being published in 1941 as a Memoir entitled "The Cretaceous and Associated work of Burma." On the palæontological side he made a special study of the *Echinoidea* collected by various officers of the *Geological Survey of India* in the Persian Gulf area, a description of which he published in 1933. He was given the degree of D.Sc. from Manchester University in 1938.

During much of his time in Burma, Dr. Clegg was Officer-in-charge of the Burma Party, and he obtained a very detailed knowledge of Burma's mineral resources, including her oil. This enabled him to publish a valuable paper on "The Mineral Deposits of Burma," and a Bulletin on "Tin and Wolfram," the latter appearing a few months before his death.

On returning from Burma to India in June, 1942, after a short spell in the Central Provinces and Baluchistan, he was appointed Director of the *Geological Survey of India* on 1st July 1943, and since then until his death on the 8th September this year, he was actively engaged in the important duties associated with his post, and was elaborating a scheme for the expansion of his department at the time of his death.

By his death the *Geological Survey* loses an able administrator whose knowledge and experience would have been invaluable in the immediate post-war years.

W. D. WEST

DYES FOR Dyeing & Printing

For Dyeing

TEXTILES OF COTTON, WOOL, SILK OR RAYON; JUTE, COIR, PAPER, AND LEATHER; EDIBLE OILS AND HAIR OILS AND TOILET OR WASHING SOAPS AND FOR PRINTING ALL KINDS OF TEXTILES

Refer to :—

B. SHIVCHAND AMRITLAL & CO., LTD.

POST BOX No. 256, BOMBAY

Sole Agents for L. B. HOLLIDAY & CO., LTD.

ENGLAND

ARVIND
Cloth for distinctive WEAR
INDIA'S most famous FABRICS
comprising of cotton sarees, dhoties, shirtings, twills, crepes, poplins, nainsooks, lawns, mulls, dorias and voiles.
LOOK FOR THIS MARK
ON THE CLOTH YOU BUY.
ARVIND MILLS LTD. AHMEDABAD.
Dealers and Stockists Everywhere

Index to Advertisers

	Page
Addison & Co., Ltd., Madras and Bangalore	xv
Alembic Chemical Works Co., Ltd., Baroda	xxi
The Andhra Scientific Co., Ltd., Masulipatam	xiii
Arvind Mill, Ltd., Ahmedabad	xii
Bengal Chemical and Pharmaceutical Works, Ltd., Calcutta and Bombay	xviii
J. K. Chemicals and Pharmaceuticals Co., Bombay	ix and x
Chimanlal Bhogilal, Bombay	xxii
Current Science, Bangalore	xv
D. C. M. Co., Ltd., Delhi	xvi
Hargolal and Sons, Ambala Cantt.	xvii
Hindustan Aromatics Co., Naini, Allahabad	viii
Industrial Chemical Works, Kirloskarvadi	xx
Kerala Soap Institute, Calicut	xviii
Modi Industries, Modinagar	iii
Mining and Chemical Industries Ltd., Agra	iv
Raj-Der-Kar & Co., Bombay	v
S. C. Sheth & Co., Ltd., Bombay	xxii
Scientific and Industrial Equipment Co., Ltd., Bangalore	xx
The Scientific Apparatus and Chemical Works, Ltd., Agra	xxiii
Scientific Instrument Co., Ltd., Allahabad, Bombay, Calcutta and Madras	vi
Sepulchre Brothers (India), Ltd., Bombay	iv
B. Shivchand Amritlal & Co., Bombay	xi
W. T. Surén & Co., Bombay	xix
The Textile Works, Ltd., Bombay and Ahmedabad	xiv
Tata Steel	xxiv
The Western Manufacturing Co., Fort, Bombay	xx

ON SWEETENING OFF FILTER PRESS-CAKE

1.—COMPARISON OF CO-CURRENT WITH CROSS-CURRENT SYSTEM

By J. G. SHRIKHANDE AND S. B. LAL

(*Imperial Institute of Sugar Technology, Cawnpore*)

WASHING or "sweetening off" of press-cakes is of great importance in sugar manufacture by clarification process. The press-cakes retain a fair proportion of sugar (to the extent of about 5 per cent. in the form of juice) which remains absorbed in the filtration scums. In order to prevent this loss of sugar, entirely or partly, two methods have been adopted—(1) washing inside the press and (2) washing outside the press. The latter process is now practically out of date and is replaced almost entirely by inside washing. In well-managed sugar factories, the percentage of sugar in the press-cake has now been reduced to nearly 1 per cent.

The process of inside washing is effected by means of hot water; the temperature of the water, however, should not be too high to dissolve the scum or to extract the coloured decomposition products of glucose. Kroog's filter press is widely in use in India for washing press-cake. It permits the washing in five different ways. Out of these five the three systems of washing most commonly practised are : (1) Co-current, (2) Cross-current, and (3) Diagonal current. These three systems have given varying results in the hands of different workers.

The various systems of washing were investigated in the experimental sugar factory attached to the *Institute* by Schouten, Rao and Gupta[1]; they reported that the co-current system was the most effective. Since their observations were not in agreement with those of the Dutch workers recorded in *Archief*, they pointed out the desirability of reinvestigating the problem. Schouten, *et al.*, admitted that their investigation was of a preliminary character and that a closer investigation was needed. The problem has been carefully reinvestigated and the results obtained have been recorded in this paper.

In the *cross-current system*, the wash water enters through the water canal, flows behind the filter cloth of the water plate, crosses the cake and the cloth on the juice plate and leaves through the outlet cocks of the juice plates as shown in Fig. 1. In the

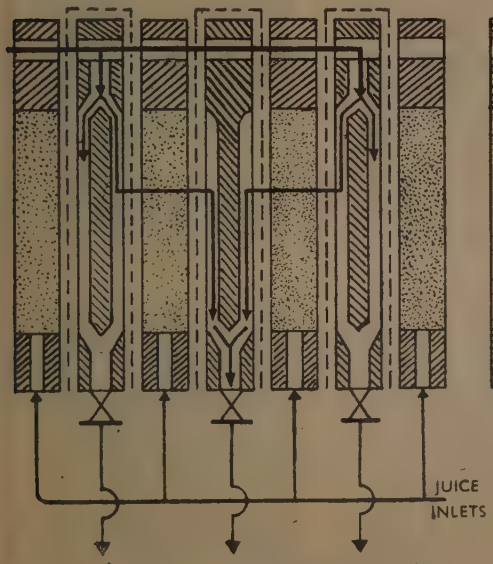


Fig. 1. Cross-current—Outlets on water plates closed.

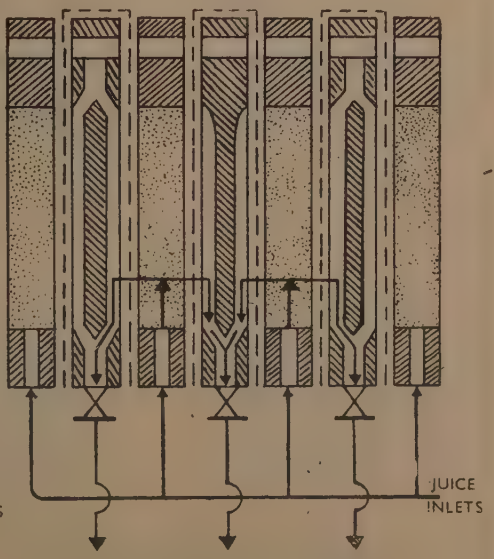


Fig. 2. Co-current—All outlets open.

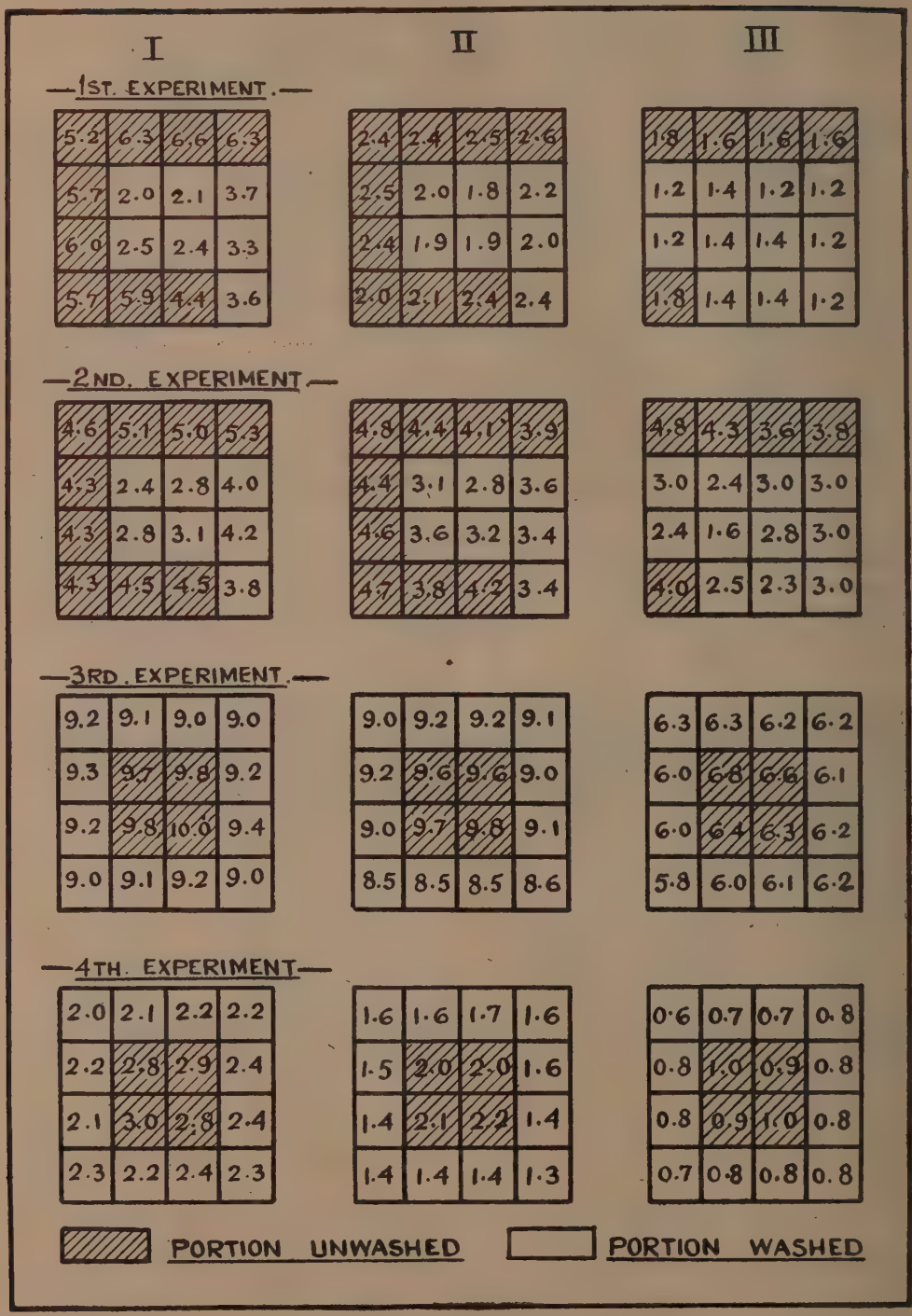

I
II
III
1ST. EXPERIMENT.
5·2 6·3 6·6 6·3
5·7 2·0 2·1 3·7
6·0 2·5 2·4 3·3
5·7 5·9 4·4 3·6
2·4 2·4 2·5 2·6
2·5 2·0 1·8 2·2
2·4 1·9 1·9 2·0
2·0 2·1 2·4 2·4
1·8 1·6 1·6 1·6
1·2 1·4 1·2 1·2
1·2 1·4 1·4 1·2
1·8 1·4 1·4 1·2
2ND. EXPERIMENT
4·6 5·1 5·0 5·3
4·3 2·4 2·8 4·0
4·3 2·8 3·1 4·2
4·3 4·5 4·5 3·8
4·8 4·4 4·1 3·9
4·4 3·1 2·8 3·6
4·6 3·6 3·2 3·4
4·7 3·8 4·2 3·4
4·8 4·3 3·6 3·8
3·0 2·4 3·0 3·0
2·4 1·6 2·8 3·0
4·0 2·5 2·3 3·0
3RD. EXPERIMENT.
9·2 9·1 9·0 9·0
9·3 9·7 9·8 9·2
9·2 9·8 10·0 9·4
9·0 9·1 9·2 9·0
9·0 9·2 9·2 9·1
9·2 9·6 9·6 9·0
9·0 9·7 9·8 9·1
8·5 8·5 8·5 8·6
6·3 6·3 6·2 6·2
6·0 6·8 6·6 6·1
6·0 6·4 6·3 6·2
5·8 6·0 6·1 6·2
4TH. EXPERIMENT
2·0 2·1 2·2 2·2
2·2 2·8 2·9 2·4
2·1 3·0 2·8 2·4
2·3 2·2 2·4 2·3
1·6 1·6 1·7 1·6
1·5 2·0 2·0 1·6
1·4 2·1 2·2 1·4
1·4 1·4 1·4 1·3
0·6 0·7 0·7 0·8
0·8 1·0 0·9 0·8
0·8 0·9 1·0 0·8
0·7 0·8 0·8 0·8
PORTION UNWASHED
PORTION WASHED

Fig 3.

co-current system, the water flows in the same direction as the flow of the juice as represented in Fig. 2.

Experimental

As the press-cake is a highly heterogeneous mass, it is obvious that little reliance can be placed on analytical data obtained by the examination of a composite sample of cake from the frame, as was done by previous workers including Schouten, Rao and Gupta. The composition of the mud varies from frame to frame in the press and from region to region within the frame itself. This is amply demonstrated by our results. Experience in Cuba[2] also supports our findings.

With a view to minimize the number of analyses, and at the same time to obtain reliable data, the length of the press consisting of 18 frames, was divided into three portions. The mud from one frame in each of the three regions was taken for examination. Each frame was then divided into sixteen equal parts and each portion weighing approximately 90 gms. was collected separately in sample bottles and analysed in the laboratory for moisture and pol in the usual way.

Only two systems of washing, co-current and cross-current, were examined and the investigation covered four experimental procedures : Thus (1) Co-current system.—Steam was introduced in the same direction as the muddy juice, as is customary in practice for the purpose of securing partial dehydration of the cake and thus impart firmness to the cake. Steaming was continued till it began to issue through the last nozzle. (2) Co-current system.—After the formation of the cake, it was first washed with water, and the washing continued until the wash water measured 35 litres. The cake was then steamed as in (1). (3) Cross-current system.—Steam was let in the opposite direction to the muddy juice, closing the alternate nozzles. (4) Cross-current system.—As in (2) but the direction of water and steam was as in (3).

There is no reason to suppose that the trend of washing under one particular system would change in the intermediate frames. Further, it may be presumed that the press-cake can be properly handled (as evidenced by the results) by any system of washing, irrespective of its thickness.

Results

In order to give a proper perspective to our findings and also to save space, the data have been presented diagrammatically in Fig. 3. The numbers represent the pol contents of the respective portions of the washed cake. The shaded portions indicate the regions of the cake where washing was not effective. From a comparison of the four diagrams, it is clear that they divide themselves into two different types. In (1) and (2), the washing is effective only in the middle of the cake, whereas in (3) and (4), the washing is more effective towards the edges. If account is taken of the pol content of the fractions of the cakes in the two sets, it is easy to see that the cross-current washing is much more effective than the co-current system. The amount of sugar leached out in the cross-current system is twice that in the co-current system. In other words, the cross-current system is twice as effective as the co-current one. (Moisture determinations in experiments 1 and 2 offered no clue as to the degree of washing ; they were not carried out in the other two experiments.)

Summary

Quantitative determinations of the pol contents of different regions of the press-cake, washed by the co-current and the cross-current systems, have shown that the latter system is twice as effective as the former. The procedure adopted in this investigation has given, for the first time, a clear idea of the trend of washing in individual frames by the two systems.

The authors are thankful to Messrs. R. C. Srivastava and A. Schouten for their keen interest in this investigation.

References

1 Schouten A., Rao K. A. N. and Gupta G. N., *Proc. Sug. Tech. Assoc., India*, 1941, p. 179.

2 Spencer G. L. and Meade G. P. *A Hand-book for Cane-sugar Manufacturers and their Chemists*, Chapman and Hall, Ltd., London, 1929.

REVIEWS

India Need Not Starve. By MICHAEL BROWN (Longmans, Green & Co., Ltd., Bombay) 1944, x+190, Price Rs. 3.

MR. BROWN'S book gives, in a handy volume of 190 pages, a connected and objective account of the Indian food problem. It is divided into four parts : food position before the war ; impact of war; Bengal famine; and the future.

Much has been said and written about our food problem since 1943. " Even when India could grow and import as much food as she wished, only 39 out of every 100 of her people were well nourished. The remaining 61 were either poorly or very badly nourished." The food position which was at no time satisfactory, assumed a serious turn after the war broke out and Burma was lost to the Allies. Inflation aggravated the situation. Profiteering, hoarding, speculative buying and other anti-social practices crept in ; the normal trade channels became suspect and people got panicky. Absence of reliable statistical data on production and distribution caused difficulties in planning adequate ameliorative measures, and scarcity of transport facilities for civilian requirements hindered free movement of foodstuffs. Rationing and price-control measures which should have brought relief were introduced only after the shortages had led to acute distress in several parts of the country. The " grow-more-food " campaign which was inaugurated early enough could not be expected to yield immediate or spectacular results. The author says : " Many tons of paper have already been used in explaining to India and the world the varying viewpoints on the feeding of India. But it seems to me that only when the whole series of official conferences between 1939 and 1943 are treated in a connected story, can we hope to understand the crabwise movements of the policy makers." It is only towards the end of 1943 that India's war-time food machine came into a smooth running order. The constitutional hurdles stood in the way of dealing with the grave food problem in a rational manner and it was only in 1943, that the Government of India deliberately adopted an all-India policy with satisfactory results.

The author who covered Bengal for the *Times of India* during the grave famine period of 1943, has given a realistic account of the harrowing situation. After examining the causes analytically, he points out : " I personally cannot escape the conclusion that the Bengal famine was entirely man-made and I believe that given adequate control, the 1943 famine could have been avoided."

The problem of the future, according to Mr. Brown, is one of correlating production with biology. Growth of population outruns production and the two must be balanced. The future food policy must aim at self-sufficiency and this view will find wide support. A two-pronged attack on food inadequacy—restriction of the growth of population and enhanced production through modern agricultural practices is suggested. The question whether population has reached the saturation limit in India and whether the present population or its rate of growth is too large for India's economic resources is a debatable one. To hold the population as the sole cause of India's plight is to take a narrow view and to admit constructive bankruptcy. India's poverty, it can be maintained on valid grounds, is not so much due to its population, as to its arrested economic development. The rational solution of our difficulties lies in raising agricultural production, and this *can* be done and *must* be done. Mr. Brown's investigations have shown that the Indian ryot is intelligent and he knows precisely how and to what extent he should exploit the soil. He is industrious. Given modern tools, better seed, more fertilizers, irrigation facilities and easier agricultural credit, the Indian ryot can produce enough to banish starvation from the land. Mr. Brown has examined the whole field of food production with an amazing degree of understanding of rural India and his constructive suggestions demand serious consideration.

India Need Not Starve is a thought-provoking contribution to India's food problem. Mr. Brown has provided a plan of campaign which aims at the solution of India's immediate and long-range food problems. It is a remarkably interesting and valuable publication.

FOREMOST and BEST

We have identified ourselves with the progress of Scientific and Industrial Research for the past decade and a half in bringing out Precision Standard Scientific Instruments.

Articles from our workshops meet every requirement for efficient service, dependability and finish.

THE RANGE OF OUR MANUFACTURES INCLUDE:

Laboratory Furniture — Gas and Water Taps

EQUIPMENT FOR:

Bacteriological — Chemical — Industrial
Pathological — and Physical Laboratories
Semi-scale Industrial Apparatus, Autoclaves,
Sterilizers, Incubators, Serological Baths,
Distilled Water Stills, Balances, Microscopes, Etc.

Large stocks of Chemicals C.P. and A.R. Quality, manufactured by us are available for immediate delivery.

It pays to obtain all your requirements from a single source. Consult us for any of your Scientific and Industrial problems.

THE ANDHRA SCIENTIFIC COMPANY, LIMITED

MASULIPATAM	MADRAS	BOMBAY
Head Office and Works	4, Blacker's Road Mount Road	12, Rampart Row, Fort
Tel: "Laboratory"	Tel: "Precision"	Tel: "Scientist"

POPATLAL GIRDHARLAL & CO.

(ESTABLISHED 1912)

49/55, APOLLO STREET, FORT
BOMBAY

Telephone : 24649
Telegram : "SNOWFLAKE"

KAPASIA BAZAR
AHMEDABAD

Telephone : 2154
Telegram : "KANTI"

MANAGING AGENTS FOR

THE TEXTILE WORKS LIMITED

SUPPLIERS OF
TEXTILE MACHINERY
AND STORES OF EVERY KIND

such as Dobbies, Jacquards, Looms, Warping, Sizing, Winding, Cropping and Shearing, Folding, Stamping, Expanders, Economisers, Dyeing, Bleaching and Finishing, etc. Also Shuttles, Picking Bands, Pickers, Diazolene, Diastoran, Melioran and Perpentol Powders, etc.

THE TEXTILE ENGRAVERS LTD.

ENGRAVERS

on Copper Rollers for the Textile Trade

Letters to The Editor

ULTRASONIC VELOCITIES AND ADIABATIC COMPRESSIBILITIES IN SOME ESSENTIAL OILS —PART II

USING the method described in previous papers, the ultrasonic velocities in a few more essential oils have been determined. Table I gives the values obtained at frequencies shown against them.

TABLE I

No.	Name of oil	Temp. in °C.	Frequency of oscillation in mc./s.	Velocity in m/s.
1	Oil of orange ..	29.0	7.55	1,300
2	Lavender ..	28.5	5.54	1,310
3	Palmarosa ..	27.0	5.63	1,192
4	Patchauli ..	27.5	5.64	1,266
5	*Manjal* (turmeric)	29.0	5.63	1,394
6	Aniseed ..	28.5	14.03	1,451
7	Petitgrain ..	28.0	13.63	1,391

From a knowledge of the densities, which were determined, the adiabatic compressibilities were also calculated. These are given in Table II.

TABLE II

No.	Name of oil	Temp. in °C.	Density	Ad. Compr.
1	Orange ..	29.0	0.9147	65.46
2	Lavender ..	28.5	0.9239	63 93
3	Palmarosa ..	27.0	0.8606	82.81
4	Patchauli ..	27.5	0.9581	65.97
5	*Manjal* (turmeric)	29.0	0.8884	58.66
6	Aniseed ..	28.5	0.9810	61.77
7	Petitgrain ..	28.0	0.9187	56.98

The important points which emerge from the foregoing results can be stated briefly as follows :

1. The low velocities (<1,300 m/s.) in palmarosa and patchauli oils indicate that they contain predominantly aliphatic compounds. Chemical analysis has shown that the former contains geraniol (75 to 95 per cent.) and the latter, an alcohol, $C_{15}H_{26}O$.
2. Oil of *manjal* (turmeric) gives a velocity of 1,394 m/s. which shows the presence of ring structure in its compounds.
3. A velocity of 1,451 m/s. in the oil of aniseed, reveals the presence of compounds of aromatic origin. It is also indicative of the high viscosity of the oil.
4. Petitgrain contains mainly the 5-membered ring compounds, pyrol and furfural, though to a very much smaller extent it contains also β-pinene, camphene and dipentene. The high velocity of 1,391 m/s. can be attributed to the presence in it of ring structures.

The authors desire to express their thanks to Mr. P. A. Narielwala, Director, *Tata Sons Ltd.*, for kindly giving us the essential oils mentioned above, without which the above work would not have been possible.

A. PANDE.
M. PANCHOLI.
S. PARTHASARATHY.

Council of Scientific and Industrial Research, Delhi, 9th November 1944.

EXTRACTION OF RUBBER FROM *CRYPTOSTEGIA GRANDIFLORA*

CRYPTOSTEGIA GRANDIFLORA, a large, woody, deciduous, laticiferous shrub with twining branches, is found growing in many parts of India. It is said to be a native of Madagascar, but has become naturalized in this country. As it yields rubber of as good a quality as that from *Hevea*, it has been regarded as a possible war-time source of rubber. Investigations are therefore being carried out in various laboratories in India and abroad to extract rubber from this plant. Its rubber content varies, depending upon the season, soil, age and part of the plant. Leaves have been found to contain rubber upto 4.5 per cent.[1], while stems, on an average, contain 0.3–0.5 per cent.

Work was started in these laboratories on the extraction of rubber from this plant at the request of the Supply Department, and a method was developed in which dried,

chopped twigs and leaves were boiled in acidic and alkaline solutions, and then treated with steam, when rubber was released; it was then separated by flotation[2].

An improved method has now been developed; yields upto 90 per cent. of the rubber content have been obtained in preliminary experiments. The process consists of the following stages :—

(1) Preparation of raw material :—Shoots are harvested and allowed to partially dry. They are then defoliated and twigs are chopped to small pieces. Twigs and leaves are treated separately.
(2) Preliminary disintegration, both physical and chemical, by boiling the raw material in weak alkaline solution and then keeping for some time.
(3) Washing the pulp from (2) and bringing it to a suitable pH.
(4) Ball-milling.
(5) Washing the pulp from the mill and releasing it in a large volume of water, when worms of rubber float up and can be easily removed.

Full details are being worked out to obtain optimum conditions. These include storage of raw material under rot-free conditions to avoid deterioration of rubber in the first stage; (*a*) strength of alkali used, (*b*) duration of boiling, and (*c*) duration of keeping, in the second stage ; the pH. range in the third stage ; and (*a*) dilution of pulp and (*b*) duration of ball milling, in the fourth stage.

All these factors together with the economics of the process are being systematically studied.

S. S. Bhatnagar.
Karimullah.
Umashankar.

Laboratories of the Council of Scientific and Industrial Research, Delhi, 10th November 1944.

References

1 Viswanath, B., *J. Sci. and Ind. Res.*, 1943, **1**, 356.

2 Bhatnagar S. S., Karimullah and Khalsa, R. G., *Unpublished report.*

THE I. C. I. AND THE BRITISH UNIVERSITIES

THE Directors of the *Imperial Chemical Industries, Ltd.*, have announced their decision to provide 80 Research Fellowships in 9 British Universities to be held by senior workers in "chemistry or physics or in an allied science which has some direct relation to the manufacturing interests of the *Imperial Chemical Industries, Ltd.*, such, for example, as physical chemistry, biochemistry, colloid science, chemotherapy, pharmacology, engineering or metallurgy." The field prescribed is broad enough to cover the entire background of modern industry. The offer is announced to operate for an initial period of seven years. The main purpose of the scheme is to strengthen the general provision for fundamental research and teaching in the Universities and is based on the recognition that post-war scientific and industrial research would be greatly jeopardized unless provision is made for a continuous flow of men trained in the fundamentals of physical and allied sciences, into the research laboratories of industry. The offer is unique inasmuch as the Universities have been given complete freedom of action both with respect to the selection of men and the choice of the subject. It is reasonable to hope that the scheme will lead to the emergence of "a body of men capable of taking high academic and industrial positions, thereby advancing academic and industrial research."

The Directors of the *I.C.I., Ltd.*, have given a lead which leaders of high finance and industry may well follow. The stimulating example to industry as a whole, set by the late Mr. J. N. Tata, who with rare foresight and generosity founded a great Research Institute in India, nearly three decades ago, has hardly been excelled. The House of Tata has been in the forefront of the benefactors of science and their generosity has known no geographical or racial boundaries. The need for strengthening Universities in India needs no eloquent pleading. It is to be hoped that Indian industry, inspired by the examples set by the late Mr. J. N. Tata, and the *I.C.I., Ltd.*, will realize that in fostering science in the Universities lies the surest means of fortifying its own position in the post-war years.

INDUSTRIAL UTILIZATION OF MAHUA

By N. G. CHATTERJI

THE Mahua tree (*Bassia latifolia*) is a natural habitant of North and Central India, and not long ago, the ownership to a number of these trees by a villager was considered a valuable asset, on account of the fact that the mahua flower has high food value, and at one time used to be stored by villagers as a sort of partial insurance against any failure of crop. With the improvement in transport facilities for foodgrains, the insurance value of mahua trees depreciated rapidly and for some time now they have received very little attention. Yet the present acute food situation and the horrors of last year's starvation devastation in certain parts of India should again draw our attention to this effective, although crude, scheme of insurance against scarcity of food. Apart from this, the products of the mahua tree are such that they can be put to industrial uses of considerable importance.

The mahua tree grows wild both in Northern and Southern India; it can also be easily planted and thrives well in plantations. Both the varieties of the tree—*Bassia latifolia* of the north and *Bassia longifolia* of the south—give flowers containing large amount of sugars, and seeds rich in a good quality of oil. The tree is plentiful in Gujrat, Hyderabad, South Kanara, Malabar, Central India, Central Provinces, Chota Nagpur, Oudh, Hazaribagh and Palamau, and it is significant to note that in most of these parts of India there is practically no sugarcane cultivation and hence no cane sugar factories.

On account of the richness in sugars of the mahua flowers and the ease with which they undergo fermentation to produce alcohol, mahua flowers have always formed, next to molasses, the most important raw material for the manufacture of alcohol in this country. But during the last few years, due to the growth of the sugar industry and the availability of an abundance of molasses, the use of mahua flowers for this purpose dwindled down rapidly and the usual trade channels for the collection and supply of mahua flowers have disappeared. However, the question of developing the power alcohol industry in India has again aroused interest in mahua flowers, especially in view of the fact that they are available in those parts of the country where there is scarcity of molasses. In this article it is proposed to indicate a rational method for the manufacture of alcohol from mahua flowers, as the process at present in use in most of the Indian distilleries, is crude and unsatisfactory.

Collection and Storage of Mahua Flowers

The flowers fall from the trees during a particular period of the year and have, therefore, to be collected and stored for a long time. As moisture leads to deterioration, it is necessary to dry the flowers as soon as they are collected and never to store them in bulk in the moist condition. The distillery godown should, therefore, be designed so that the flowers may be stored in comparatively thin layers and they should be turned over from time to time to bring the lower layers to the top. There should also be fairly good arrangement for ventilation. Temperature within the mass of the flowers at different places should be taken at regular intervals, as any unusual rise is an indication of deterioration. It would be a good plan to make an arrangement by which the flowers before storage are dried by the waste chimney gases.

Preparation of Wash

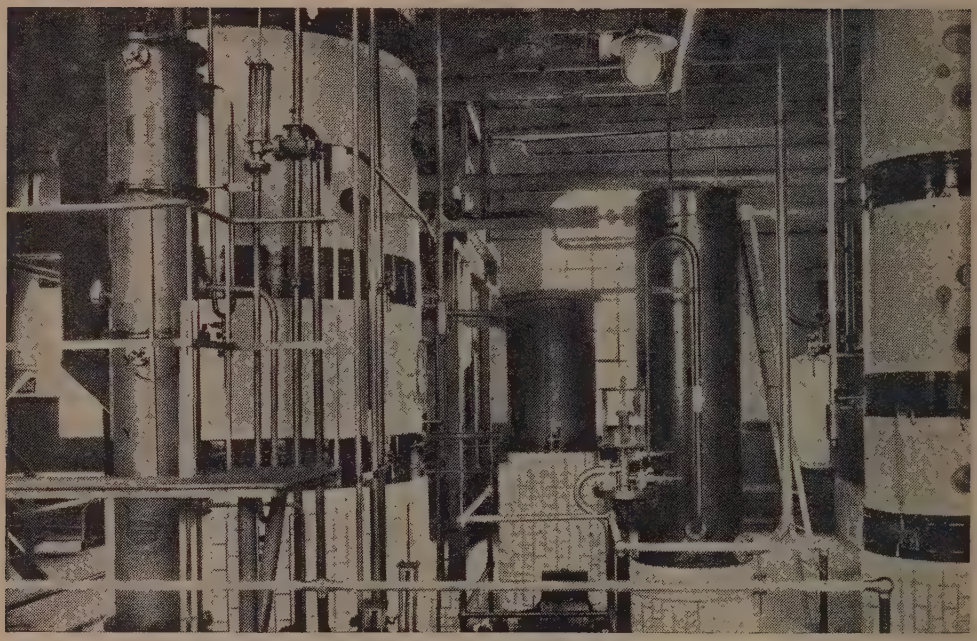
Mahua flowers, fairly dry, contain about 60 per cent. of sugars, consisting mainly of sucrose and invertose. The preparation of the wash should be conducted in such a way that :

(*a*) the initial gravity of the wash may be about 1.080,

(*b*) the sugars left unextracted in the spent flowers may be as low as possible ; and

(*c*) during the process there should be no undesirable fermentation due to bacterial action.

These objects can be achieved by the adoption of what is known as the battery system of extraction in series using hot spent wash for the first extraction followed by fresh water. In arranging for the proper plant, care should be taken to see that the flow of the liquid is kept in its natural direction, that is to say, the liquid of higher specific gravity should be displaced by one of lower gravity from the top, so that the



General view of Distillation and Rectification columns in operation.

flow may be in the downward direction. To prevent bacterial action, it is recommended that the water used for extraction may be slightly acidulated with sulphuric acid. For guidance it may be mentioned that the amount of sulphuric acid used should be such that in the final wash the acidity may be about 0.5°.

At present, in India, fermentation of mahua wash is allowed to take place with the natural ferments and not with pure yeast culture. Improvement in this direction is very desirable. For this purpose, the wash should be heated with open steam in order to sterilize it and then cooled through heat exchangers before its passage into the main fermentation vats. In any case, if the entire quantity of the wash cannot be sterilized, at least a portion of it which is to be used in prefermentation vessels should be so treated. In other words, the process which is adopted in modern distilleries using molasses wash should also be adopted with mahua wash.

The removal of the spent flowers should be done with care. Within the fermentation house there should be no accumulation of these and the dumping ground should be at some considerable distance, preferably in a covered pit.

Distillation and Rectification of the Fermented Wash

The fermented wash from mahua flowers has one great advantage over that from molasses, in that the scaling troubles encountered with the latter in the wash column are entirely absent in this case. The result is that the time lost in stopping the plant for cleaning the scales is saved and the average monthly production from a plant of a given output is higher.

The Coffey type of patent still with which most of the older Indian distilleries are equipped are incapable of producing spirit of either sufficient purity or high strength. These stills were primarily designed for making Scotch whisky which should retain some of the "impurities" present in the fermented wash (prepared from malted barley) along with the alcohol to give the required taste and aroma. Similarly, the spirit obtained from mahua wash using the Coffey type of still retains the characteristic odour and taste of the mahua, while the strength of the spirit is rarely above 90 per cent. This is all very well as far as the marketing of "country liquor" is concerned, for which a certain section of the drinking public has acquired a taste. But most of the

industries require a much higher quality of spirit and it is, therefore, necessary to install the distillation and rectification plant designed with the object of eliminating all the impurities either more volatile or less volatile than alcohol. Fortunately the theoretical aspects of the rectification of alcohol are fairly well known and within the last two years, complete distillery plants comparable in design with the best of the imported plant have been constructed and put in operation in this country.

In the design of the rectification plant, particular care should be taken to incorporate in it an effective device to remove what are known as the tail products. Though the exact nature of these products in the case of mahua spirit is not known, yet they may be assumed to be those, the rectification coefficient for which becomes less than unity when the alcohol per cent. in the boiling liquid is about 45. Any of the well-known devices may therefore be adopted to work in conjunction with the rectification column from which liquid could be drawn from a number of plates near the range where the strength in alcohol of the boiling liquid is about 45 per cent. In passing, it may be pointed out that data relating to rectification coefficients of the impurities present in mahua spirit are lacking and their determination is of the utmost importance to the industry. To adapt the Coffey still for producing spirit of about 68 O.P. without seriously curtailing the output is a comparatively simple matter and this has been carried out, under the advice of the author, in a number of distilleries. Likewise it should not be at all difficult to attach a small additional plant to work in conjunction with the Coffey still for improving the quality of the spirit.

Economic Considerations and Future Planning

Due to the absence of any reliable data, it is difficult to make an estimate of the quantity of flowers that may become available for the alcohol industry; but enquiries made in this direction by the author go to show that the amount would be considerable. On the lowest estimate the yield of flowers per tree may be taken as half a maund, and the total quantity of flowers that may be made available with some sort of organization for collection, can be easily about 50,000 tons per year. In normal times the price of mahua flowers varies widely in different parts of the country. Some of the distilleries were reported to have paid as high as Re. 1-8 per maund, while others secured at as low a price as As. 6 per maund. A maund of flower should give about 2.4 gallons of alcohol, so that in the mahua trees that are already available in the country, we have a potential source of raw material for the supply of some 3.25 million gallons of alcohol.

In any future planning for the development of the alcohol industry in this country, the following points should be taken into consideration :—

(1) The country's need for power alcohol is of first importance and should be kept in the forefront.

(2) Drinking spirit is a luxury article and the industry can easily afford to use comparatively dearer articles as raw material, such as low grade *gur* and drainings from *gur* godowns.

(3) Every available source of raw material should be tapped and organized in such a way that the more costly ones are directed to drinking spirit and the lesser ones to industrial and power alcohol distilleries.

(4) The Government should hold a monopoly for the purchase and sale of alcohol, on lines similar to those which existed in most of the countries of Europe in pre-war days. It is significant that a start in this direction has already been made in the case of power alcohol.

(5) Thorough overhauling of the obsolete, die-hard conservative excise policy and a drastic change in the present training of the excise officials is called for. The training concentrates on the "watch and ward" duties and creates a mentality which is antagonistic to the development of industrial alcohol.

(6) An equitable adjustment between the rate of excise duty levied on power alcohol and on petrol is essential for ensuring the progress of the industry. At present the duty levied is the same on both the fuels.

Attention may be drawn to the fact that mahua seeds contain a high percentage of oil, which is mostly used for making soap, but which when subjected to the usual process of refining and deodorization can form a good quality of edible oil.

THE USE OF PRODUCER-GAS FOR MOTOR TRANSPORT

CONFERENCE OF TECHNICIANS IN NEW DELHI

By H. B. DUNNICLIFF

(*War Transport Department*)

ALTHOUGH, the present necessity for using charcoal as a raw material for an alternative motor fuel came prominently into notice on account of the war, it is only just to the Indian pioneers in this field to remember that the first attempt to introduce producer-gas for use in motor vehicles in India took place at Nagpur in 1936, the "Cecoco" plant of Japanese origin being used; but the experiment was not successful. About the same time, a vehicle was running on producer-gas in Madras and, in the next year, the *Madura Mills* fitted plants to some Chevrolet lorries which, even in 1941, were still running on gas. Between 1937 and 1940, *Indian Agencies* of Nagpur made a plant called the "Kirlosker" with some success, but the company stopped production after about forty units had been sold.

In April, 1938, the Chief Conservator of Forests in Madras ordered an inquiry into mobile producer-gas plant operation and the business was taken up by *Messrs. Simpson & Co.* in the Presidency capital. After extensive trials and tests, a successful demonstration was given in June, 1939, and, towards the end of that year, the "Simpson" plant was put on the market. About the same time, other firms working in the producer-gas field before petrol rationing was announced, were *Messrs. T. V. Sundram Iyengar and Sons* of Madura and the *Andhra Engineering Co.* of Bezwada. Producer-gas transport was tried in other parts of India but real enthusiasm for charcoal-gas transport seems to have been confined to the Madras Presidency which still leads in this field, having, at the present time, about 70 per cent. of all its passenger buses and civilian load lorries converted to gas.

When the war in Europe broke out in the autumn of 1939, it soon became apparent that shipping was going to suffer and that the prospect of India getting her requisite quantity of petrol from the Persian Gulf and Burma was problematical. Many anticipated such shortage and there were early rumours of petrol rationing. Certain enterprising firms and small engineering business concerns got actively to work and the mobile gas-plant industry did a roaring trade, the demand for plants exceeding the supply, with the result that indifferent plants were thrown together and rapidly increasing prices were obtained for them.

Petrol rationing commenced in August, 1941 and, by that time, the number of vehicles running on gas had risen to 535 buses and 41 trucks, all of them plying in South India, Madura leading with 165 vehicles. The Government of India did not view with complacency the threatened shortage of motor spirit and, early in the war, appointed Mr. N. C. Watney to conduct an inquiry into the "Use of Carbonaceous Fuels as a Partial Substitute for Petrol in Motor Vehicles." His detailed report, submitted in 1941, gave hopeful prospects of charcoal gas, but it also contained very pertinent warnings regarding the difficulties of using it, both on account of the lower power generated as compared with petrol and the risk of spoiling engines if the gas was not properly filtered free from dust.

Briefly, he recommended that Government should prohibit the sale of gas plants which did not comply with certain specifications, particularly with respect to gas cleanliness and robustness of design, and that testing authorities should be set up to approve plants as suitable for fitment to motor vehicles. He advised research work leading to the design of a standard plant for use in India and urged the necessity for an investigation into the manufacture of efficient charcoal.

The Government of India acted promptly on these proposals and the War Transport Department drew up certain specifications and model rules directed, *inter alia*, at public safety in the use of this fuel and the prevention of undue wear and tear of engines by the use of badly designed gas plants. The chief requirement of public safety lies in the adequately strong construction and proper

placing and fitting of the gas plants on the vehicles.

The main protection against unsuitable plants was the recognition that all models must pass a gas purity test and the criteria set forth in the Australian Specifications were adopted for the purpose. A well equipped testing station was set up at the *College of Engineering, Guindy, Madras*, and shortly afterwards, the War Transport Department, in collaboration with the *Board of Scientific and Industrial Research*, arranged for the installation of a testing station at Delhi. Similar laboratories are also in active operation in Bombay, Calcutta, Nagpur and Trivandrum and it is felt that these six stations can probably deal with the proving of all new model plants so far as India is concerned.

As some differences of opinion arose concerning certain details of the bench and road tests and also with regard to other technical points, the Department of War Transport decided to convene an all-India Conference of Producer-Gas Technical and Testing Officers and invited Provincial Governments and certain Government of India Departments to send delegates and suggest subjects for discussion.

The Conference met in the Imperial Secretariat, New Delhi, from 12th—14th October 1944, under the chairmanship of Sir Kenneth Mitchell, Chief Controller of Road Transport and Development.

The Conference was opened by the Honourable Sir Edward Benthall, Member of His Excellency the Viceroy's Executive Council for War Transport, who expressed particular pleasure in being able to attend because he felt that the extension of the use of producer-gas plants for road transport had reached a crucial stage. He said that people were inclined to feel that petrol would be readily available when the war in the West was over, but warned those present that quite the contrary would be the case. The maximum demand for transport in India, whether on road or rail, had still to come and the necessity for economy in motor spirit was as great as ever. He hoped that the number of chassis to be released in 1945 would be much greater than in previous years but he could give no guarantee that more petrol would be available. This position continued to justify the War Transport Department in compelling purchasers of new chassis to install producer-gas plants on their vehicles to the maximum extent possible. This would help the war effort and guarantee convenience to the owner and his goods who would have the further satisfaction of having done the right thing if, later on, as was quite possible, it became necessary to reduce petrol rations. Sir Edward Benthall expressed the appreciation of the Government of India of those Provincial and State Governments and individuals, including the experts, who had effected what is, in fact, a notable achievement, the conversion of thirty per cent. of India's motor buses and civil lorries to producer-gas, but he urged a still greater effort so that the target of fifty per cent. conversion might be attained.

In pursuance of this objective, he stated that Government had determined that neither the manufacturers nor the users of producer-gas plants should fail for lack of adequate scientific advice and information, and made the point that it was the technicians who, in conjunction with the manufacturers, could ensure that the plants marketed were the best possible. He informed the Conference that it was the policy of the Government of India to encourage the opening of driving schools under official control and also the teaching of drivers by manufacturers, and that applications for the release of chassis or trucks for this purpose would be considered by his Department. It was in these matters of design, servicing, efficient driving and fuel control that Government looked to their technical advisers and, while mindful of the success which had so far attended their endeavours, he hoped that much more would be done.

In this connection, the Honourable Member stressed the urgent demand for stepping up the manufacture and distribution of suitable charcoal throughout the country and the immediate necessity for an all-India inquiry into the insistence on improved methods of production. He stated that, in all matters of scientific progress and control, technical advisers and inspecting officers would have the support of the War Transport Department and that he was confident that the deliberations of the Conference would not fail to further the end which the Government of India had in view.

The first item discussed was the necessity for the uniformity of bench tests for proving model producer-gas plants throughout India. One of the main difficulties in this regard had been due to the fact that an uniform

filter paper was not used for the gas purity test. Dr. L. C. Verman (Delhi) read a paper on the determination of the porosity of dry filter paper and was emphatic in his recommendation that all laboratories should use the same kind of filter paper. This was generally approved, as was also the offer of Dr. Sri Krishna (Dehra Dun) to investigate the possibility of manufacturing a standard filter paper at the Forest Research Institute. After some delegates had made preliminary remarks indicative of the various views held on the problems to be tackled, a sub-committee was formed to discuss in all details the standards and procedure for conducting the bench tests. They later submitted a completely unanimous report and the detailed recommendations were discussed and approved by the Conference with a few minor amendments.

Second only in importance to the chemical and power tests on model plants are the road tests to determine the performance of each model under load and when subjected to varying road conditions. Reports from Provinces had revealed that, largely owing to geographical limitations, the tests at present in practice varied fairly widely. That road tests should be compulsory was generally approved but there was some divergence of opinion on the question of their length, the gradients which should be considered suitable criteria and the frequency with which such tests should be applied. Here again, there was a co-operative exchange of views, the result being an uniform set of rules for road trials which, with certain minor limitations, would be applicable all over India.

It is a truism that the damage caused to engines when producer-gas is used, is very largely due to the fact that the fuel gas carries over with it a certain amount of finely divided charcoal dust and the discussion of the problem of gas filtration occupied the attention of the Conference which, in this respect also, hoped to arrive at some standard criterion for dealing with this problem. Dr. Verman and his collaborators recommended certain cotton cloths on the basis of accurate scientific investigation and Mr. H. D. Chowdhury (Calcutta), arguing forcibly that corrosion was also due to chemical action, advocated the use of water or oil gas-scrubbers, and suggested an investigation into the possibility of a standard design for wet filtration.

Emphasis was also laid upon the absolute necessity for freeing the air which passes into the gas mixer from dust in a manner similar to that in which air is drawn into the carburettor through an oil filter in a petrol-driven engine, for the same purpose. The debate on this subject introduced the problem of top cylinder lubrication and Col. J. Allen explained the new controlled crank-case ventilation system fitted on all Ford engine sumps, a device which ensures a certain amount of upper cylinder lubrication. It was also mentioned that a similar device has been introduced on Chevrolet engines.

The argument as to whether a final oil filter should be made compulsory on the ground that the fuel gas passing through it entrained some oil as mist which provided upper cylinder lubrication was inconclusive, the consensus of opinion being that a badly designed oil filter was more trouble than no filter at all, and that no really well designed oil filter, which would permit the gas to carry some atomised oil with it, had so far been incorporated into any Indian model.

For the success of large-scale producer-gas transport, it is essential that an ample quantity of fuel should be available. In India, although other alternative fuels are being tried out, the only raw material at present used in mobile producer-gas plants is charcoal and, in introducing this subject, Dr. Sri Krishna gave a highly condensed thesis on this important subject. Sir Edward Benthall also took part in this debate and stressed the importance of securing supplies of good quality charcoal if the transport needs of the next year or more were to be met. The Conference regarded with concern the possibility that the producer-gas drive might be held up through lack of fuel and resolved that the attention of the Provincial and State Governments should again be drawn to the imperative necessity of providing maximum possible supplies and organizing the distribution of good quality charcoal. It was further suggested that the resources of each Province and State should be investigated to determine whether, if necessary, the country should be zoned into districts where producer-gas plants could be used and those in which, owing to charcoal shortage, this form of road transport was not practicable.

JUST PUBLISHED

THE DECIBEL NOTATION

AND ITS

APPLICATIONS TO RADIO ENGINEERING AND ACOUSTICS

BY

V. V. L. RAO

(RADIO ENGINEER, GOVT. OF MADRAS)

FOREWORD BY

Prof. S. P. CHAKRAVARTI

(HEAD OF THE DEPT. OF ELEC. TECHNOLOGY, INDIAN INSTITUTE OF SCIENCE, BANGALORE)

The only authoritative work on this important subject

Demy 8vo. 180+xviii pages, 52 figs. 47 Tables and One two-colour frontispiece of Decibel chart

Price Rs. 8/12 postage extra

For copies apply to the Publishers:

ADDISON & CO., LTD.

MADRAS & BANGALORE

Current Science

A monthly journal of science devoted to the publication of the latest advances in pure and applied sciences.

Issued under the auspices of the Working Committee of the **CURRENT SCIENCE ASSOCIATION,** with the Editorial co-operation of prominent scientists in India.

Annual subscription .. Rs. 6 or 12s.

Single copy .. .. Re. 1 or 1s. 6d.

(Postal and V.P.P. charges extra)

Advertisement Rates for Single Insertion

Full page	.. ..	Rs. 36
Half page	.. ..	„ 20
Quarter page	.. ..	„ 12

(Special long-term contracts on application)

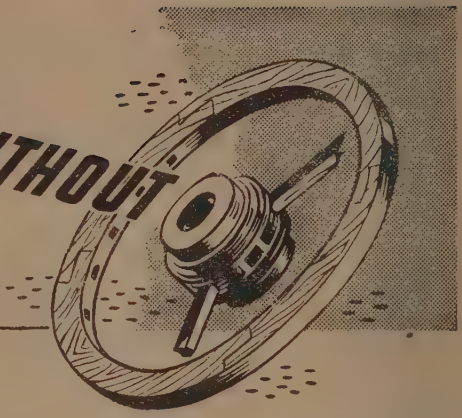
Particulars from :

THE HON. SECRETARY

CURRENT SCIENCE ASSOCIATION

MALLESWARAM P. O., BANGALORE

AS IN A WHEEL WITHOUT Spokes



There would be many imperfections in manufacturing processes and in the quality and finish of manufactured goods without the aid of good and dependable chemicals.

D. C. M. Chemical Works and Daurala Chemical Industries were started many years ago to supply high-grade chemicals to D.C.M's industrial enterprises. The experience, scientific skill and knowledge of the needs of industry so gained are now at the disposal of all Indian industries through factories keyed to large-scale production of chemicals of quality and dependability.

CHEMICALS MADE BY D.C.M.
Nitric and Hydrochloric Acids · Ferrous Sulphate Potash Alum · Glauber Salt Ferric Alum · Bone Glue and Turkey Red Oil.

ALSO PAINTS & VARNISHES
Stiff Paints. · Varnish Paints · Copal Varnish Ready-mixed Paints All in various shades.

THE DELHI CLOTH & GENERAL MILLS CO., LTD., DELHI

DCM. 38.

In discussing the subject of manufacture, several types of kilns, including the American Oven Kiln, were discussed. It was felt that the retort process for making charcoal depended too much on the necessity for finding a market for the by-products, and that the initial cost would be very high, the metals necessary would probably not be available and that, in any case, the time which would be necessary to put the plants into operation would preclude their use as a war measure. The Forest Research Institute all-metal portable kiln was favoured but, here again, it was anticipated that steel would not be obtainable to put anything approaching an adequate number of them into commission. Stress was therefore laid on the "improved pit kiln" (Indian Forest Leaflet No. 53), for which no new material is required, the iron roof being made from any waste steel sheets which could be made available packed at unavoidable joints by mud plaster. A good quality dirt-free charcoal can be made in these kilns at low cost and it was suggested that, if necessary, the assistance of an expert instructor to tour the Provinces and explain the system could be secured.

Mr. E G. Salter (Travancore State), himself an inventor of a producer-gas plant, recommended the evolution of a standard model plant for India and his offer to initiate work in collaboration with Mr. Deshpande at the *College of Engineering, Trivandrum*, on the design of such a plant was welcomed by the Conference. In this connection Mr. B. Sengupto (Bombay) said that more attention should be paid to steam or water injection to increase power and reduce charcoal consumption.

Mr. D. Purnayya (Madras) felt that the War Transport Department's restrictions on the small manufacturer with respect to the release of controlled materials were too stringent, and made certain suggestions by which he might be allowed to continue in business and be supported in his industry. In replying to his complaint Dr. Dunnicliff said that the policy of issuing considerable amounts of controlled steel to a large number of small manufacturers had not proved a success, and that the Department was being put to considerable trouble to reassemble much unused material which had been distributed in this way but which fortunately was still available for collection. He said that the War Transport Department would help the small manufacturer if he received special recommendation from the Provincial Motor Transport Controller who had special knowledge of the case, but that producer-gas plant manufacture as a cottage industry had little to recommend it.

Mr. Chowdhury gave a number of interesting instances of the methods by which persons who resisted orders to fit producer-gas plants were convinced that gas transport was suitable for their work, and briefly described investigations into the inefficient running of certain fleets by direct trials over their respective routes. The Conference resolved that such methods for the settlement of disputes regarding the suitability of producer-gas transport for particular kinds of work by direct trial, should be adopted whenever possible.

Although it is true that, in the past, insufficient attention has been paid by certain manufacturers to the policy of following up sales by adequate arrangements to inquire into complaints by dissatisfied buyers, there is every indication that the "Service After Sales" aspect of commercial producer-gas business is receiving increasing attention from the manufacturers of mobile producer-gas plants, many being willing to conduct actual trials over disputed routes or with respect to types of work said to be unsuitable for gas transport. The necessity for the maintenance of a really reliable service of spare parts was emphasized by many speakers and it is satisfactory to know that an increasing number of plant manufacturers now are able to supply from stock most of the parts of their plants for replacements or repairs.

Mr. Achuthan Nair (*Board of Scientific and Industrial Research*) gave a synopsis of his paper, a copy of which was in the hands of each delegate, on the necessity for research work on producer-gas problems and, as a result of the recommendations of the expert Sub-Committee appointed to standardize the bench test and a consideration of Mr. Nair's paper, the Conference decided to set up a Standing Producer-Gas Research Committee which, subject to the approval of the respective administrations, should consist of the testing officers in charge of the laboratories at Madras, Calcutta, Bombay, Nagpur, Delhi and Trivandrum, with one member of the War Transport Department as co-ordinating chairman.

The future of the six Testing Stations was discussed and the opinion was expressed that perhaps their utility might be limited to the duration of hostilities. The majority, however, were of the view that much valuable work could be done in these testing stations for many years to come. The Conference was informed that the War Transport Department had recommended to the *Inter-University Board* that mobile producer-gas plants, their manufacture and operation, should be included in the curricula of Engineering Colleges as it was hoped that, with the attempts that are being made to put producer-gas transport on a firm basis, its life would not be limited to the duration of the war, but that it would become an established indigenous industry serving a permanent system for the movement of goods and travellers throughout India.

Sir Edward Benthall joined the Conference when the necessity for making provision for the teaching of drivers and the instruction of technical inspectors in connection with producer-gas transport was discussed. On this subject there was complete unanimity of opinion, the only question which arose was how the drivers were to be taught. It was ultimately resolved that Provinces should be requested to arrange free schools for drivers who should be taught in their own language by lectures, demonstrations and actual driving and who, when they passed an oral and practical test, should be given a certificate of efficiency.

The subject of the design of district buses both with and without producer-gas equipment and the possibility of a standard pattern for all parts of India has arisen. At the present time, when so many essential materials are in short supply, it is perhaps difficult to construct really attractive passenger buses. At this Conference the delegates naturally discussed only the influence of producer-gas plants on design, particularly with respect to load distribution, passenger accommodation and comfort in public service vehicles. In general, it was decided that every effort should be made to build the best type of body with the minimum of material and that the front axle : rear axle load distribution, when carrying its full permissible load, should not fall below 20 : 80. It was also decided that it is desirable but not compulsory to recess the gas-plant and that its weight should fall within the overhang of the vehicle, which should not exceed 45 per cent. of the wheel-base.

Finally, the subject of the housing and maintenance of fleets of passenger or load vehicles was discussed. It was pointed out that, in many cases, no adequate arrangements exist for cleaning, greasing, repairing and garaging the motor vehicles between their periods of work on the roads. Tentative proposals have been included in the report in which an attempt is made to describe, in some detail, an efficient layout and the minimum tool equipment and maintenance programme required for a small service garage providing for a fleet of about ten vehicles.

Sir Kenneth Mitchell thanked the delegates for attending the Conference and for the material contribution they had made to its usefulness by subscribing papers on the subjects of which they had made a special study. Their keenness in the discussions had raised their deliberations to a high scientific level. He hoped that the result of their exchange of views and the resolutions they had passed would be the increased operation of road transport on producer-gas.

On behalf of the delegates, Dr. C. Forrester (Labour Department, Dhanbad) thanked the Honourable Member for the stimulus his presence and personal interest had given to their deliberations. He congratulated the Chairman on the competent manner in which he had presided over the debates and kept an enthusiastic body from digressing too far from the point immediately under consideration. He also expressed the appreciation of the delegates for the work of Dr. Dunnicliff in making the arrangements and for supplying so comprehensive an agenda, the consideration of which had been much facilitated by the relevant literature which had been distributed. He was expressing the views of his colleagues when he said they felt sure that the Conference would have fruitful results, and that it would be in the general interests of the continued development of producer-gas transport if another meeting were arranged in the near future.

THE TINPLATE INDUSTRY IN INDIA*

IN view of possible misconceptions arising from the popular uses of the words "tin" and "tin sheets" it may be advisable to preface this article by explaining that tinplates and tinned sheets are steel plates or sheets coated with what is little more than a *veneer* of actual tin and that tins are fabricated from tinplates, not from pure tin, which, apart from being costly, would be too soft for the purpose.

The lack of an indigenous tinplate industry was acutely felt in India during the first Great War, when the normal imports of around 50,000 tons annually were almost entirely cut off and distribution of kerosene, petrol and vegetable oils was very seriously disorganised. Fortunately the post-war expansion of the *Tata Iron and Steel Co.'s* Works in Bihar made possible the establishment of a tinplate factory in India. *The Burma Oil Co.* and the *Tata Iron and Steel Co.* were the joint sponsors of the *Tinplate Co. of India, Ltd.* Its factory was erected at Golmuri, Tatanagar, and the management was entrusted to *Shaw Wallace & Co.* of Calcutta.

Spacious planning and up-to-date devices for water and air-cooling solved the problem of the arduous rolling operations during the intense heat of the summer months.

Manufacture began in December 1922 and the whole plant was operating a year later. During this period there had been intensive training of the locally engaged labour by the skilled operatives who had been brought out from S. Wales. In the early years numerous difficulties, arising from the inexperience of Indian labour and the remoteness of the factory from certain essential stores and raw materials, were encountered and successfully overcome. By 1926 it was established that Indian labour was sufficiently hardy and adaptable for the work, that a first class tinplate could be produced in spite of climatic difficulties, and that a much greater output could be obtained from the plant than that for which it had been designed.

The timely tariff policy of the Government of India and the far-sighted patience and resources of the promoters, averted a crisis in the industry during the years immediately after the post-war boom. During a decade and more of steady progress, the output of the industry doubled the 28,000 tons planned for originally. In 1939 the Golmuri Works was producing 90 per cent. of the tinplate consumed in India.

The war brought in its train a number of new problems for the industry. Countless new sizes and gauges, and new qualities of specially high grade tinplate had to be produced. After the occupation of Malaya by the Japanese, there had to be a change-over of a great portion of the output from tinplate to *terneplate* (on which the coating is a mixture of lead and tin) and to *blackplate* which is the steel base without any protective coating.

The Tata Iron and Steel Company of Jamshedpur supplies the Golmuri Works with steel sheet bar, electricity and water. The 3,500 men who work for the *Tinplate Company* are housed comfortably and looked after in every way.

Raw Materials

Steel sheet bar (tinbar) and block tin are the only two raw materials which actually go to make tinplate. The production of first class tinplate at Golmuri is largely due to the excellent quality of tinbar supplied by the *Tata Iron and Steel Company*. Tinbar is itself a semi-finished product, having already been rolled from the steel ingot into bar to a definite analysis and specification. For tinplating the purest tin obtainable is required and supplies are normally imported from Malaya. Latterly Chinese tin has been used and although inferior in quality to Malayan, it is satisfactory for general purposes during wartime.

Specialized items of equipment and stores are required in tinplate manufacture, as, for example, hot and cold rolling mills, annealing boxes, palm oil, zinc chloride, etc. Originally all these had to be imported and early attempts to discover sources of supply or substitutes in India were unsuccessful. Recent developments, however, have changed the situation and it is possible that after the war

* Contributed by *The Tinplate Company of India, Ltd., Calcutta,* to *the Dictionary of Economic Products and Industrial Resources of India.*

all these requirements will be available locally. Sulphuric Acid is used in large quantity in the process and the *Works* contains its own plant for acid manufacture.

The Process

The manufacture of tinplate consists of three essential processes, the rolling of the steel bar into sheets, the preparation of these sheets for tinning, and their actual coating with tin. In the first process, the steel bar, $\frac{1}{2}''$ thick, is reduced by alternate heating, rolling and doubling to the required thinness of the finished tinplate, which may be 12-thousandths of an inch, as for the kerosene tin, or less, as for biscuits or cigarettes, or more, as for the petrol can. In this department, apart from climatic considerations, the work is very arduous and requires considerable skill and experience.

The steel leaves the rolling mills in packs of 8 sheets about 60″ long and 30″ wide which are then sheared to size and separated by hand. After pickling in dilute sulphuric acid to remove scale and after annealing in a continuous furnace in order to render them pliable, the sheets, after a second pickling are rolled cold under high pressure to give them a suitable surface for the tinning process.

The tinning machines are automatic. The plates first pass through zinc chloride, which acts as a flux, and then through molten tin and palm oil. They are finally cleansed in a dusting machine as they pass into the warehouse, where they are sized and sorted and packed for the market. The thickness of the tin coating varies according to the purpose for which the tinplate is to be utilized but is normally about $1\frac{1}{2}$ per cent. of the total weight of the sheet. The bulk of the demand for tinplates in India is for the manufacture of kerosene and petrol tins, but large quantities are also supplied for packing tea, butter, fruit, biscuits, cigarettes, vegetable oil and ghee, as well as for the manufacture of articles such as lamps, plates, cutlery, toys and the like. The Golmuri works manufactures almost every size, gauge and quality of tinplate for which there is demand in India. The only qualities not produced by the works are the specialities known as *Taggers*, very thin plates less than eight-thousandths of an inch, and *Tinned sheets* which are hand dipped.

Markets

Outside India, the industry finds possible markets in Singapore for canning of pineapples, and in the Persian Gulf for packing of oil. Burma might come into the market after the war. The development of canning in India, fostered by war conditions, will absorb the maximum economical output of the industry as it stands. The core of the demand is likely to remain, as now, the needs of the oil companies for packing kerosene, but there is very great scope for increase in the existing trade in vegetable oils and ghee and for new developments in the canning of processed foodstuffs. In this direction and in the popularizing of lacquered and decorated tinplate for a variety of uses, the advent of the *Metal Box Company of India, Ltd.*, is having a revolutionary effect on the trade.

Future Developments

The improved technique in modern manufacture is to be seen in three directions :—

(*a*) mechanical rolling of hot strip in place of manual rolling of short lengths of tinbar,

(*b*) cold reduction to the final gauge, also in strip form, in place of hot rolling throughout, and

(*c*) electro-tinning in place of hot-dipping.

Rolling, whether hot or cold, in strip form offers definite advantages in control of gauge and uniformity, but it is not yet possible to foresee its application to the Indian industry. Electro-tinning also has attractive possibilities, since a very much thinner coating of tin can be applied than by the hot-dipping method. There are, however, disadvantages from the fabricators' point of view in a reduction of the tin coating and it is possible that electro-tinning will not long survive the war, which has brought it into prominence by reason of the shortage of tin.

References

1 Leyston, J.—*Report on Tinplate Industry in Bihar and Orissa*, 1932.

2 *Report of the Indian Tariff Board* regarding the grant of protection to the Steel Industry, 1926, Vol. VII (Evidence recorded during the enquiry into the question of continuance of protection to the Tinplate Industry).

THE SINGHBHUM COPPER BELT AND THE INDIAN COPPER CORPORATION LTD.*

THE whole length of the belt contains ancient mine workings whose age is unknown, but whose size and number point to a large and thriving industry and a comparatively high degree of civilization that worked the belt for copper in ancient days. The existence of copper in Singhbhum has, however, only been known to British enterprise since the early part of last century and the first hint of the occurrence of copper in Dhalbhum was made exactly 110 years ago, in 1833, by a Mr. Jones.

In 1847 the occurrence of copper in Singhbhum was first definitely established by Captain J. C. Haughton, assistant to the Governor General's Agent in the South-West Frontier, but it was not until 1857, that the first *Singhbhum Copper Company* was formed by certain Calcutta interests and dissolved in 1859.

In 1862 a company—*The Hindostan (Singhbhum) Copper Company*—commenced operations at Rajdoha with a capital of £120,000 but in 1884 this *Company* became defunct.

In 1869 Valentine Ball, an eminent geologist, wrote an interesting paper endeavouring to show that the Jats or Seraks (lay Jains) were the ancient people who first worked these copper deposits.

In 1891 attention was again turned to the district and a portion of the copper belt in Dhalbhum was taken on lease direct from Government. From this concession the *Rajdoha Mining Company* selected an area extending from Rakha to Rajdoha and comprising about 24 sq. miles.

Work was done by the new *Company* at both Rajdoha and Rakha but appears to have been limited by lack of funds.

As a result of a report on the copper prospects of the district by Sir Thomas Holland between 1905 and 1909, the *Geological Survey of India* put down several borings along the belt in Singhbhum. The result of these borings aroused further interest and the *Cape Copper Company* under the management of *Messrs. John Taylor and Sons* secured an option on the lease held by the *Rajdoha Mining Company.*

In 1907 and in 1908, the *Cape Copper Company* bought the lease outright for £14,000 from the *Rajdoha Mining Company* and carried on prospecting and development work at Rakha mines until 1914, when the mill was started and production commenced. Production operations continued until 20th June 1921 when the Receivers took over the mine and on 31st March 1922 production ceased, although the mine was kept open until 1931.

An option was taken on this property by the *Indian Copper Corporation, Ltd.*, in 1929 but was not exercised.

In 1920 the *Cordoba Copper Company*, under the management of *Messrs. John Taylor and Sons*, took an option on the Mosaboni area of some 20 sq. miles from the *Cape Copper Company* and started prospecting. The option was exercised in 1924 and the mining rights of the area purchased from the *Cape Copper Co.* On 21st July 1924, this *Company* was reconstructed as the *Indian Copper Corporation, Limited*, with a capital of £225,000 and the new *Company* at the same time took over the properties of the *North Anantapur Gold Mining Co.* and the *Ooregum Gold Mining Co.* at Sideshur and Kharswan. Work was, however, confined to the Mosaboni area where development continued until February 1927, when the management of the *Indian Copper Corporation, Limited*, was taken over by the *Anglo-Oriental and General Investment Trust, Ltd.* Debentures for £350,000 underwritten by the new management supplied funds for the erection of power plant, concentration mill, and smelter on the north side of the Subarnarekha River near Ghatsila. Erection of plant commenced without delay resulting in the commencement of production operations in the closing months of 1928.

In July 1930 a rolling mill for the production of yellow metal or brass sheet was completed and the first yellow metal sheet made in India was produced.

In 1931 the technical management of the *Corporation* was handed over to the *New Consolidated Goldfields, South Africa, Limited*, under whose management operations still continue.

* Contributed by *The Indian Copper Corporation, Ltd.*, to the *Dictionary of Economic Products and Industrial Resources of India.*

In 1932 further debentures for £125,000 supplied funds to increase the plant and increase the production by 50 per cent. This extension of plant was completed in October 1933 and the authorized capital of the *Corporation* now stands at £900,000, all debentures having been paid back.

Since ore-winning operations commenced in 1929, up to the end of 1944, a total of 3,894,980 long tons of ore has been treated for a production of 78,333 long tons of refined copper.

Operations

The sequel of operations from the mining of ore to the production of refined copper ingot and yellow metal sheet and circles, is given below and is also outlined in the diagrammatic flow sheet on page 277.

The Mines.—The *Corporation* operates three mines. Mosaboni and Badia on the same line of lode adjoin one another and workings extend for a horizontal distance of 2½ miles. It is possible to walk from one end to the other without coming up to the surface. A smaller mine at Dhobani is situated one mile to the west of Mosaboni. The method of extracting the ore is similar in all the three mines. A brief description of the Mosaboni Mine is given below :

Mosaboni Mine.—Two parallel lodes on ore bodies dip at approximately 30° from the horizontal and are developed by inclined shafts and levels or tunnels driven along the lode at different horizons. The distance between horizons measured down the incline or dip of the lode is about 220'. The intervening ore is removed by "stoping" and falls or is scraped down to chutes. Tram lines are laid along the different levels and the ore is taken from the chutes and trammed to ore bins in the main hoisting shaft. The grade of ore varies from 1.8 to 3 per cent. copper.

All breaking of ground is done by rock drills, operated by compressed air and the holes so drilled are blasted each night. The explosive used is gelignite. On the present scale of operations some 20 tons per month of explosives are consumed.

From the shaft ore bins, the ore is hoisted in 5½-ton self-dumping skips by a 450 h.p. electric hoist operating a double skip or cage road to a surface ore bin in the shaft head frame.

This surface ore bin feeds a primary crushing plant, where the ore is crushed in two stages to a size of "minus ½ inch" and where the elimination of waste rock by hand picking is carried out.

From the primary crushing plant, the crushed ore is carried by belt conveyor to the aerial ropeway bins, and from there by aerial ropeway a distance of 6 miles to the concentrating mill and smelter at Moubhandar. Surface plant at the mine, in addition to the electric hoist and crushing plant already referred to, consists of compressed air plant, drill sharpening plant, workshop and foundry.

All plant is electrically operated and power is supplied from the *Corporation's* main power plant at Moubhandar over a duplicate overhead power line at a pressure of 11,000 volts.

Moubhandar.—At Moubhandar the aerial ropeway discharges the roughly crushed ore into reinforced concrete ore bins feeding the concentrating mill.

In the concentrating mill the ore is first ground by ball mills to the requisite degree of fineness to separate the copper-bearing mineral from the surrounding gangue or waste rock, and then passes to the oil flotation plant, where the copper bearing mineral is separated by flotation and then filtered and dried.

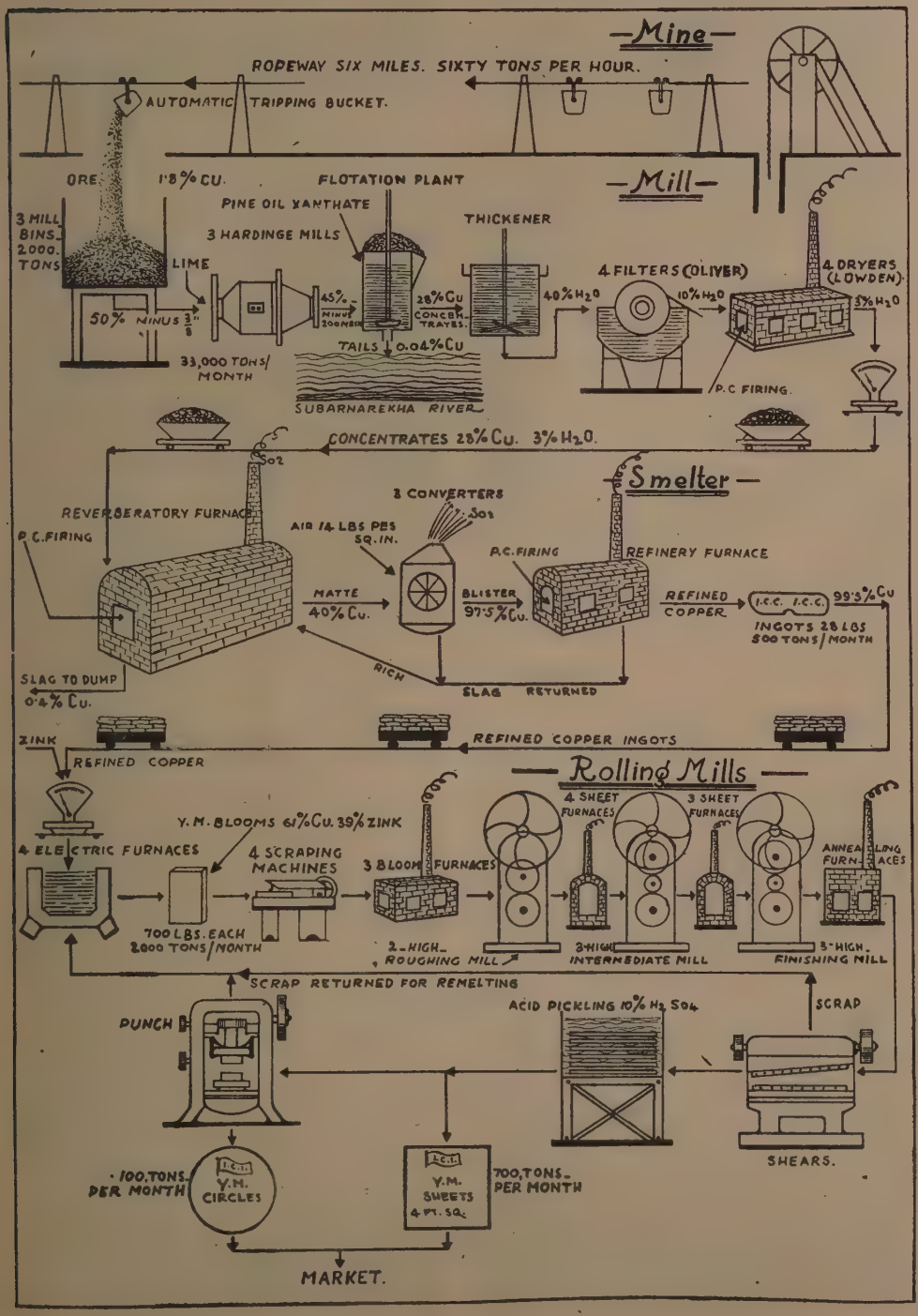
The resulting product known as concentrates consists essentially of finely ground copper-bearing mineral assaying approximately 30 per cent. copper and containing approximately equal parts of copper, iron and sulphur. The waste or tailings are pumped away and settled on adjoining waste land.

The dried concentrates are now ready for treatment in the smelter, where in successive stages, the sulphur is driven off as sulphur dioxide gas and the iron and other impurities are fluxed and removed in the form of slag, leaving molten refined copper which is ladled and cast into ingots.

It is noteworthy that from the time the ore is deposited in the underground bins, until the worthless rock, from which the copper sulphide has been extracted is pumped away, the whole process is automatic, no handling being necessary.

The successive stages in the smelting plant are : pulverized coal-fired reverberatory furnace, Bessemer converters and pulverized coal-fired refinery furnaces.

The resulting product known as 'B S' or 'Best Select' copper ingot, assays from 99.2 per cent. to 99.6 per cent. copper.


—Mine—
ROPEWAY SIX MILES. SIXTY TONS PER HOUR.
AUTOMATIC TRIPPING BUCKET.
ORE
1·8% CU.
FLOTATION PLANT
—Mill—
PINE OIL XANTHATE
3 MILL BINS 2000. TONS
3 HARDINGE MILLS
THICKENER
LIME
4 FILTERS (OLIVER)
4 DRYERS (LOWDEN)
45% MINUS 200 MESH
28% Cu CONCR. TRAYES.
40% H2O
10% H2O
5% H2O
50% MINUS 3/8"
TAILS 0·04% Cu
33,000 TONS/ MONTH
SUBARNAREKHA RIVER
P.C FIRING
CONCENTRATES 28% Cu. 3% H2O.
—Smelter—
3 CONVERTERS
SO2
REVERBERATORY FURNACE
AIR 14 LBS PER SQ. IN.
P.C. FIRING
REFINERY FURNACE
MATTE 40% Cu.
BLISTER 97·5% Cu.
REFINED COPPER
I.C.C. I.C.C.
99·5% Cu
INGOTS 28 LBS
500 TONS/MONTH
SLAG TO DUMP 0·4% Cu.
RICH SLAG RETURNED
ZINK
REFINED COPPER INGOTS
—Rolling Mills—
REFINED COPPER
Y.M. BLOOMS 61% Cu. 39% ZINK
4 ELECTRIC FURNACES
4 SCRAPING MACHINES
3 BLOOM FURNACES
4 SHEET FURNACES
3 SHEET FURNACES
ANNEALING FURNACES
700 LBS. EACH
2000 TONS/MONTH
2-HIGH ROUGHING MILL
3-HIGH INTERMEDIATE MILL
3-HIGH FINISHING MILL
SCRAP RETURNED FOR REMELTING
ACID PICKLING 10% H2 SO4
SCRAP
PUNCH
SHEARS.
100. TONS PER MONTH
I.C.C.
Y.M. CIRCLES
I.C.C.
Y.M. SHEETS 4 FT. SQ.
700. TONS PER MONTH
MARKET.

Normally, a portion of this is marketed in ingot form, the main consumers being the Calcutta and Bombay Mints, the Indian railways and the Calcutta bazaar. The major portion is converted by the addition of zinc into brass or yellow metal sheet having a composition of 62 per cent. copper and 38 per cent. zinc.

In the yellow metal foundry, copper and zinc ingots are melted in electric induction furnaces and cast in water-cooled moulds as blooms in which form after preliminary scraping of the surface, they are suitable for rolling.

In the Rolling Mill, two-stage hot rolling is carried out, the blooms being heated in specially designed furnaces, rough rolled to plates, reheated, rerolled to the requisite gauges and cut into 4′ square sheets.

Annealing and pickling of the finished sheet is necessary before they are ready for the market and a small proportion of the total output is cut and marketed as circles.

Output is on a scale of 700 tons of finished sheet per month and all output is marketed in India, and distributed to consumers through the metal markets of Calcutta, Bombay and Madras.

The power plant situated at Moubhandar supplies power for all plant at Mosaboni and Moubhandar in addition to camp lighting, water-supply, etc.

The plant consists essentially of a battery of six water tube boilers fired by pulverized coal and six high speed turbines operate alternators of a total capacity of 5875 k.w.

A central coal pulverizing plant and two unit pulverizers, reduce slack coal to the necessary fineness for firing by pulverized coal and all water required for domestic supply and the numerous processes is pumped by electric pumps from the Subarnarekha River.

As assisted siding connects the plant site to the Bengal Nagpur Railway main line at Ghatsila, the *Corporation* is well served for all essential supplies.

The *Corporation* employs a total of 5,900 persons of which 4,240 are engaged in the mines and in the workshops at Mosaboni, whilst the balance of 1,660 are engaged in the Reduction Works and Rolling Mill at Moubhandar.

INDUSTRIAL RESEARCH PLANNING COMMITTEE

COMMENCING from the last week of September 1944, the Industrial Research Planning Committee, under the chairmanship of Sir R. K. Shanmugam Chetty, held meetings at several important places interviewing representatives of Indian States, Universities, research institutions, and commercial and industrial organizations.

The subjects discussed were: (1) the relation between "pure" and "applied" research, (2) the need for strengthening the scientific departments of various Universities for carrying on research in all branches of science—pure as well as applied, (3) the establishment of larger number of studentships and fellowships in Universities on attractive terms and the extent to which the Universities should collaborate with industrial organizations on specific problems relating to industry, (4) proposals for improving and developing the applied science departments of Universities with the aid of an initial block grant so that they may form an integral part of the scheme of Scientific and Industrial Research, (5) the need and possibility of bringing research organizations in Indian States within an all-India scheme, (6) the necessity and possible methods of stimulating a favourable outlook on advancement of research by industrialists and make them sponsor research organizations of their own on the model of Research Associations in the United Kingdom, and (7) establishment of specialized research institutes for promoting the industrial development of the country.

The Committee have obtained valuable information from these interviews on all the above points and in particular with regard to the administration of Scientific and Industrial Research on an all-India basis and the representation of varied interests on the central administration.

It is understood the Committee have arrived at tentative conclusions on all major points of the inquiry on the basis of a five-year plan and their report is expected to be ready by the end of January 1945.

NOTES AND NEWS

Rust and Corrosion Removal from Metal Surfaces

IN a report presented to the *American Gear Manufacturers' Association* by its Lubrication Committee, comprehensive information is given on corrosion removal.

1. *Surfaces that have not been machined.*—The method used for removing rust or corrosion will depend on the depth of the corrosion and the type of surface needed after the corrosion has been removed. Scratch-brushing is simple but may leave the surface quite rough. Sand-blasting is effective in cleaning metal surfaces preparatory to the application of most protective coatings under conditions where pickling or other methods of cleaning are impractical or inadequate ; sometimes chilled steel shot is used instead of sand. But this method does not remove tightly adhering mill scale nor clean the crevices as well as pickling. It may leave the metal with a rather smooth and less desirable finish.

Corrosion in the form of scale can be removed by pickling, using a 5 per cent. solution of hydrochloric acid or a 5 to 10 per cent. sulphuric acid solution. The bath is kept at about 180° F. (82° C.) by the injection of steam. The disadvantage of pickling is that a large amount of the scale comes off first, and while the remainder is being removed, the bare metal exposed is eaten away more rapidly. It is possible also to cause brittleness of the metal, due to the absorption of hydrogen. If this occurs, the ductility of the metal may be largely restored by heating it in water at boiling point for several hours in an open tank. Some organic compounds added to the pickle solution help to keep down acid fumes and to protect the exposed metal from overpickling without reducing the rate of scale removal.

Electrolytic pickling may be used for special work. The surface of the metal may be cleaned by making it the anode or the cathode in an electrolyte through which a current is passed. When used as the anode, the rapid solution of the metal and oxygen liberated at the surface loosens the scale. When used as the cathode, the hydrogen deposited on the surface reduces the oxide scale and aids in removing it.

2. *Surfaces that have been machined.*—Slight amounts of rust may be removed by the use of oil and crocus cloth. For removing a very light coating of rust, there are solutions available that are quite effective. In no instance can it be expected that a smooth, polished surface will be left after any of the above treatments, as the rust coating is never eaten away evenly. However, surface corrosion should be removed before attempting to cover it with any preservative coating (*U.S.O.W.I., Mechanical and Electrical Engineering Newsletter*, No. 1, 1944, *Machinery*, June 1944).

Moth-proofing of Furs

A discovery of considerable practical value has been announced by the chemists of the *Imperial Chemical Industries*. The discovery relates to the moth-proofing of furs.

Among the measures that have hitherto found use in preventing moth damage to wool, furs and other keratinous material, are storage of materials in cedarwood boxes and refrigerators, and superficial spraying with chemicals toxic or repellant to moths. Among the chemicals which are toxic to moth larvæ are hydrofluoric acid, and pentachloro-dihydroxy-triphenylmethane. It has now been found that proteinous fibres treated with saturated sodium chloride containing small concentrations of formaldehyde and hydrochloric acid, become highly moth-proof. While the corrosive nature of the solution renders its use in the wool trade somewhat doubtful, its use in the moth-proofing of furs is practicable (*C.T.J.*, 1944, 115, 115).

The method of application is very simple. Fleshed rabbit skins are dipped in a bath of saturated sodium chloride solution containing 1 per cent. formaldehyde, and hydrochloric or sulphuric acid, the liquor ratio being 25 : 1. Best results are obtained at pH. 0.5 and at 25-35° C. After two days, the skins are removed, rinsed from the liquor, the flesh side coated with a mineral oil fat-liquoring agent, and dried at the room temperature. The salt is rinsed by gentle brushing. The fur so treated is not only toxic to larvæ but also repellent to female moths which are deterred from laying eggs on them. The treated furs can be dyed in the same manner as that obtaining in commercial practice. The bath liquor can be renovated by the addition of acid and formaldehyde to the required degree.

Recent Developments in Storage Batteries

New techniques in storage-battery materials and construction arising from the war, will provide many advantages in economy, efficiency and battery life. All the batteries designed for military service by *Willard Storage Battery Company*, have polystyrene plastic containers, which are transparent, easy to clean, immune to the corrosive effect of the electrolyte, lighter than glass and stronger than hard rubber. Most of them use fibrite, a remarkable new insulation developed from non-critical materials which so effectively retards shedding of active material from the cell plates that no sediment space is provided at the bottom of the containers, thus permitting the use of larger, higher-capacity plates with no increase in overall cell size. This insulation absorbs 90 per cent. of the elctrolyte within a cell. The remaining 10 per cent. is trapped by a non-spill construction secured by extending the walls of the vent tube downward. Tipped upside down these batteries do not spill electrolyte (*Diesel Power and Diesel Transportation*, July 1944).

Because this new insulation absorbs so much of the electrolyte and keeps it in contact with plates, batteries using it continue to function when their containers are cracked or even completely destroyed. It is possible to ship these batteries in the fully charged state, yet without the necessary electrolyte. In this condition, they may be held in stock indefinitely without self-discharging or deteriorating in any way. To prepare them for instant use, it is only necessary to add electrolyte. Some of the models have specific

gravity indicators moulded into their transparent plastic containers. The gravity indicator balls are visible at all times so that the state of charge can be easily determined.

An outstanding characteristic of the new batteries is their high electrical capacity in relation to their physical size. One of the batteries is only 29/32″ (23 mm.) high, weighs only 6 ounces, (170 gm.) but develops 36 volts (*U.S.O.W.I., Mech. & Elec. Eng. News Letter*, No. 2).

Production of Cigarette Leaf Tobacco

Mr. Bimal K. Khanna, of *Messrs. Indo-Virginia Tobacco Co.*, writes :—The mass production of Cigarette Virginia Leaf Tobacco has a very great future in India as a good market is assured for it both in India and in foreign countries. There is great scope for producing more and more of quality tobacco leaf every year, by increasing the acreage under this crop and by employing efficient and economical methods of production under expert guidance.

The mass production will become possible only if the problem is taken up in earnest by zamindars holding large tracts of land, and by progressive cultivators. Demonstration farms should be organized, as they constitute an effective means for the introduction of new crops. The cultivators would be too ready and willing to take up the cultivation of tobacco, if they are assured of a ready market for their produce. The zamindars can maintain nurseries on behalf of the cultivators, as this operation needs care, and they can issue the seedlings to cultivators as soon as they are ready for transplantation. In order to take charge of the green leaf from the cultivators, zamindars and purchasing firms should start flue-curing barns and godowns at every growing centre. The green leaf should be cured under expert supervision. Cured tobacco should be properly graded, packed and despatched to the consuming firms.

The conditions needed for the cultivation of Virginia Cigarette Leaf Tobacco, are—plentiful supply of water, light soil without water-logging, and open land.

The cultivation of tobacco has been taken up in the U.P. on a commercial basis with great success. The response from agriculturists for the cultivation of this economic crop has been very encouraging.

Large-scale cultivation of tobacco in suitable tracts under proper management will bring good returns to the cultivator and help in relieving rural indebtedness.

Tobacco Development Scheme

A comprehensive scheme for the improvement and development of tobacco in India has been sanctioned by the Governing Body of the *Imperial Council of Agricultural Research*, at a cost of Rs. 16 lakhs.

The direction of this work will be taken over by the *Indian Central Tobacco Committee* which is likely to be set up next winter. The *Committee* will be responsible for research, development and marketing of all kinds of tobacco grown in India, and for its finances the Government are already allotting Rs. 10 lakhs annually from the Tobacco Excise Fund.

Consolidation and Development of Mica Industry

According to a Press Note (Labour Department, dated 24th October 1944), the Central Government have appointed a Mica Enquiry Committee to enquire into the immediate as well as the long-term problems of the mica mining industry. With the Hon'ble Mr. Justice D. E. Reuben, I.C.S., of the Patna High Court, as Chairman, the Committee consists of Lala Guru Sharan Lall, and M. Md. Ismail Sahib. Rai Bahadur Rai Hardatta Prasad has been appointed Secretary to the Committee.

The Committee will be assisted in their investigations by assessors from the mica trade and industry and by technical advisers from the Geological Survey of India and the Board of Scientific and Industrial Research. Rai Sahib Pradhan Suryavarti Prashad, Inspector of Mica Accounts, Kodarma, representing the Bihar Government, Mr. E. Watson and Mr. Chand Mal, representing the Bihar mica miners and dealers, Mr. S. Y. Krishnaswami, representing the Government of Madras, Mr. D. Narayana Reddi, representing the Madras mica trade and Mr. Chapal Bhattacharya, representing mica labour, have been appointed as assessors. The Directors of the Geological Survey of India and the Board of Scientific and Industrial Research, will be technical advisers to the Committee.

While the Committee will generally enquire into and report on all problems relating to the mica industry and its present and future developments, they will specifically examine and report on immediate problems relating to the Mica Control Order, 1940, both in regard to war production and long-term policy, and the review of any orders that may have been passed by Government in connection with that Order; the present system of marketing—both inland and abroad; standardization of quality; the extent to which alternative sources of supply may have jeopardized or are likely to jeopardize the position of India as the principal supplier of muscovite mica; the extent to which other materials that may be used as substitutes for mica, may have displaced or are likely to displace mica from its uses in the industry; increased utilization of mica in India for the manufacture of finished goods; methods of development with special reference to research, conservation, mining, processing, marketing and meeting competition; and the desirability of setting up a suitable machinery whether by the appointment of a Central Mica Committee or otherwise to watch the interests of the mica trade and industry.

The Committee will have its headquarters at Patna and will tour in mica mining areas to take evidence on the spot.

Bengal Statistical Bureau

The Government of Bengal have decided to set up a Provincial Statistical Bureau. Each Department of the Government will be instructed to keep the Bureau informed of their activities in statistical matters and to seek the guidance of the Bureau when it proposes to introduce new schemes or methods.

The function of the Bureau will be primarily advisory in character. It will impart technical advice regarding the collection of primary statistics, classification, tabulation and analysis of statistical material and the form of publication of statistical data.

Dam Across the Godavari

A gigantic irrigation plan, estimated to bring into cultivation nearly 2 million acres of land in the Godavari delta, is now being prospected by a

Special Public Works staff of the Madras Government. The idea is to explore the possibilities of erecting a dam across the Godavari in the higher reaches of the river's course lying through the hills and Agency tracts and harness the waters for agriculture and, if practicable, for power production.

Nobel Prize Awards for 1943 and 1944—

Physiology and Medicine, 1943.—Professor Kenrik Dam, Copenhagen, and Professor Edward Adelbert Doisy of Saint Louis, Missouri, for the discovery of Vitamin K. The Vitamin was discovered by the two workers at the *Biochemical Institute* of Copenhagen as a result of dietary experiments on chickens. It is the antihæmorrhagic vitamin, considered necessary for the formation of an enzyme which plays a part in blood clotting and finds important uses in medicine, e.g., in preventing hæmorrhage after operations for obstructive jaundice and in the bleeding disease of new-born babies. The Award for 1944 is shared jointly by Professor Emeritus Joseph Erlanger of Saint Louis and Professor Herberts Gasser of New York, for outstanding work on the manifold and functional differentiations on nerves.

Announcements

Dr. S. K. Banerji, D.Sc., O.B.E., has been appointed Director General of Observatories, in succession to Dr. C. W. B. Normand, C.I.E., with effect from 10th September 1944.

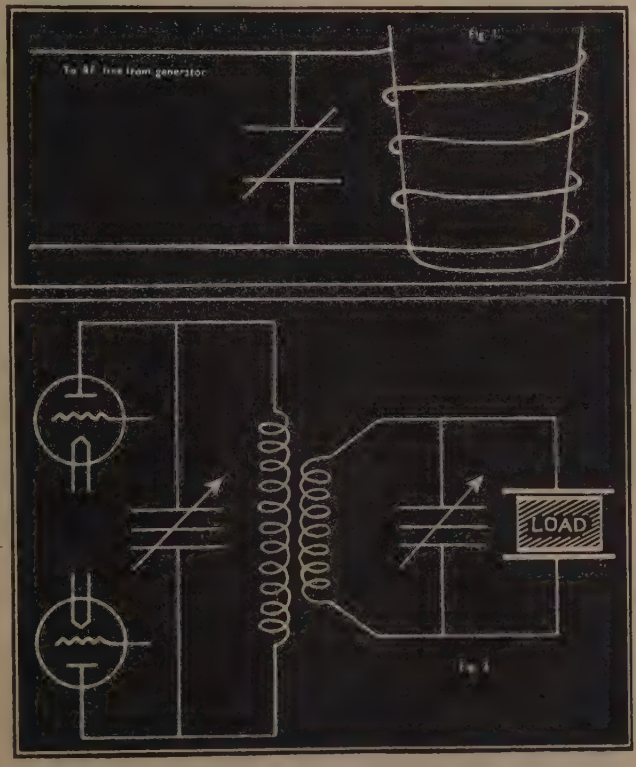
Mr. R. P. Bahadur has been appointed Secretary, *Council of Scientific and Industrial Research*, Delhi. He took charge of his duties on the 14th November.

Council of Scientific and Industrial Research.—During the absence of Sir S. S. Bhatnagar, who is now on a visit to the United Kingdom and the United States of America, the technical work of the Council, Board and the Research Committees, will be carried on by Dr. S. Parthasarathy, who will exercise, with respect to these activities, the powers of the Director, Scientific and Industrial Research, under the general supervision and guidance of the Vice-President and the President.

RADIO POWER FOR PROCESSING CHEMICAL MATERIALS

THE heating phenomenon associated with radio frequency power has been known for a fairly long time, but not many years ago, the prospect of using a radio apparatus for work that could be done readily and cheaply by steam, hot air or other abundant power, must have appeared ludicrous to radio and heating engineers alike. However, radio frequency is now rapidly coming into the fore as a leading method of industrial heating; not only is it doing some jobs more economically than other types of heating but many jobs which could not be accomplished at all with conducted heat.

Induction heating is the most widely used method of employing radio frequency power for industrial purposes. As is well known, in all high frequency oscillating circuits, a certain balance of inductance (coils) and capacity (condensers) is needed to make a tuned circuit, which in turn is tuned to the frequency of the generator. When this lead circuit is in tune with the generating circuit, resonance occurs and the radio frequency power (R.F.) flows through the coil and condenser of the load circuit. If a load contained in a crucible of non-conducting material, is placed within the coil as shown in Fig. 1, the oscillating current in the coil produces rapidly alternating currents in it by induction, in much the same manner as a transformer primary induces current in the secondary. These induced currents cause rise of temperature in the charge.



There are numerous industrial applications of the abovementioned type of power, but the most important of them are all confined to heating of materials of good electrical and thermal conductivity and are

of interest to the electrical and metallurgical engineers. There is, however, a method of using high frequency power to produce heat in chemical materials which are normally considered relatively poor conductors of heat and electricity and even materials which are classed as insulators. This method makes use of the electro-static field set up between the plates of the condenser. The greatest and the fundamental difference between electromagnetic and electrostatic heating lies in the placing of the work. While the load in the former case is placed within the coil, in the latter, it is placed between the condenser plates (Fig. 2) and thus forms all or part of the dielectric for the condenser, and since it is a better conductor than air, some power tends to leak through it. This power loss or absorption by the load material causes a uniform rise of temperature throughout the mass. The uniformity of mass heating is one of the chief characteristics of R.F. power which gives it a special importance.

Only during the past ten or twelve years have the commercial applications of high frequency electrostatic heating been considered seriously. The following list, showing the applications of R.F. power for different purposes, illustrates its versatility.

Heating semi-insulators.
Gluing plywood and gluing with resins, etc.
Deactivating enzymes (vegetables before freezing).
Preheat molding preforms.
Peeling potatoes.
Surgery.
Distillation (destructive, etc.)
Plasticizing rubber before milling or thermoplastic resins before extruding or milling.
Drying paper, ceramics, textiles, sensitive powdered materials, tobacco in hogsheads, etc.
Condensing or polymerizing resins.
Curing rubber.
Heavy Compreg wood propellers.
Destroying grain infestation.
Pasteurizing milk or beer.
Cooking (baking, toasting cereals, etc.)
Impregnating wood.
Stitching.
Seasoning lumber.
Chemical reactions.

Some processes lend themselves admirably to the use of R.F. power. For instance, the manufacture of Compreg airplane propellers and heavy Compreg sheets and blocks would be extremely difficult without R.F. power. It is the only method which can heat large sections quickly and uniformly to such a temperature that the impregnated resin will soften and flow under pressure and allow the wood to be compressed uniformly. Heat conducted from hot plates will precure the outside and set up undesirable stresses. Another example recently showed how preheating with R.F. power could enable a molder to turn out articles efficiently from tougher molding compounds than have been in commercial production before, because the entire preform could be heat plasticized uniformly to flowing temperature without starting precure in spots before the mold closed.

Apparently in the direct manufacture and processing of chemical material, the use of radio power has not reached the stage of an issued patent or published data, although there is a wide field open for specific applications. Some experts are of the opinion that molecules placed in the rapidly alternating electrostatic field, reorient themselves with each alternation of the R.F. current, and their great activity produces heat from molecular friction. Others contend that it is purely a resistance phenomenon and the reaction is due to the resistance offered to the passage of current. There is evidence to support both theories but more data should be gathered and analysed before a theory is evolved. The molecular structure of the material or combination of materials being heated, their dielectric constants, and the particular frequency and voltage density being applied, will probably all have great bearing on the phenomenon taking place.

It has been observed that certain materials within the electrostatic field absorb power more readily than others. This principle can be used in chemical processing in several ways such as the separation of products by distillation. Wood and coal can be destructively distilled with R.F. power and there are possibilities for radical developments in these industries. For example, the products obtained by this type of heating are not the same as those obtained where local overheating is bound to occur. Another radical departure would be to send the powdered coal or wood, in the complete absence of oxygen, through a high-voltage electrostatic field and thus bring about the destructive distillation of particles almost instantly by virtue of the heat generated within each particle and without heating the surrounding gas appreciably.

The frequency used in electrostatic heating is generally higher than that required for induction heating. The exact frequency required in a particular case depends on the nature of the job to be handled. For a given heating effect a much lower voltage is required if a high frequency is chosen. This, incidentally, is one of the advantages of electrostatic heating. In practice, frequencies ranging from 1.5 mc/s, to 20 mc/s. are employed for different types of heating operations.

The power requirements of the generating set can be obtained by calculating the B.T.U. per hour needed and converting it into kilowatts.

Condensed from the article by Jon. W. Robertson, *Industrial and Engineering Chemistry, Industrial Edition*, 1944, **36**, 440.

Reports from States and Provinces

Travancore

Sericulture

THE Agricultural and Industrial Departments are engaged in the revival of the sericultural industry in Travancore. Experimental plantations of mulberry have been started at Pangode, in the premises of the Pattom and Kowdiar Palaces and also in the area adjoining the Reformatory and the Central Prison.

Experimental rearing of silk-worms was started in 1944 with 100 layings of seed eggs obtained from Coimbatore. 67½ lbs. of raw cocoons of high quality were produced, the output being comparable with those obtaining in Mysore and Coimbatore.

According to expert opinion, the soil and climatic conditions in many parts of Travancore are favourable for mulberry cultivation, and there is every possibility of establishing a flourishing sericultural industry in the State in the near future.

Lac Cultivation

The Forest Department has taken the initiative in the cultivation of lac on *Kusum* trees, and the results obtained during the past few years have established beyond doubt that favourable conditions prevail in the State for lac cultivation. A thousand lbs. of brood lac were obtained from Vilvancode range in December 1942 and were lent to two agencies—the Matandom Y.M.C.A. Rural centre and a private individual in Central Travancore. The May 1943 harvest was extremely satisfactory and efforts have since been made to extend lac cultivation. The *Kusum* trees have proved to be the favoured host plants and they grow in abundance along the banks of numerous rivers and streams traversing Central and Northern Travancore. Tens of thousands of these trees are found in private holdings all over the State. Experience has shown that there are two seasons for the cultivation of lac—one from January to June, and the other from June to December. Under exceptionally favourable conditions, as much as 500 lbs. of lac can be produced from a tree. An average yield of 50-100 lbs. per tree can be assumed which at the prevailing market rates will fetch Rs. 25 to Rs. 50.

There is considerable scope for the organization of the industry on a State-wide scale as a spare-time occupation for the farmers.

Cotton Cultivation

The Agricultural Department initiated trial cultivation of cotton in the Aramboly Dry Crop Farm, and encouraged by the results obtained, the Department decided, last year, to bring 100 acres of land in the Mahindragiri Fuel Reserve under cotton cultivation. The area was leased out to a local ryot and the cultivation started early this year under the control and guidance of the Department. The results obtained have been very satisfactory. The cotton harvested was supplied to local spinners. It is estimated that some 20,000 acres, stretching from Aramboly to Cape Comorin, can be brought under cotton as the soil and climatic conditions are favourable for the cultivation of this economic crop.

Pyrethrum

Pyrethrum insecticides have been tried in a number of villages in Neyyattinkara taluk as an anti-malarial measure. Its wider application has been rendered difficult on account of the cost involved.

In India attempts are being made to cultivate pyrethrum in Kashmir, Punjab and elsewhere. In Travancore an experimental plantation (about one acre) was opened by the Forest Department at Peermade in the Thattathikanam Reserve at an elevation of 8,000′ above sea level. It has been found since that the Pambadamshola in Devikulam taluk which has an elevation of about 6,000′ above sea level would prove to be even more suitable for pyrethrum cultivation and an area of 25 acres was planted with pyrethrum in 1944 at Pambadamshola. As the results are encouraging, it is proposed to extend the cultivation by at least 25 acres in 1945. There is every prospect for the expansion of this important industry in Travancore.

Cinchona

The Forest Department has undertaken the cultivation of cinchona in the State. Experimental raisings have been started in an area of 6 acres in the Valanjankanam reserve near Peermade. Preliminary surveys indicate that the areas suitable for cinchona cultivation in Travancore are Pallivasal, Peermade and Kollar Valley. It is reckoned that the annual requirements of the State are well over 10,000 lbs., and for ensuring self-sufficiency, about 500 acres should be planted with cinchona.

INDIAN PATENTS

[The following is a list of Patent Applications notified as accepted in the *Gazette of India*, Part II—Section I, in November 1944.]

29857. American Cyanamid Co. Improvements in or relating to methods of preparing leather and to leather prepared therety.

29891. The Tata Oil Mills Co., Ltd. Improvements in and relating to the manufacture of vegetable protein, particularly for use in or as an adhesive.

30145. Tecalemit Ltd. Improvements relating to oil or fluid filters or cleaners.

30147. Tecalemit Ltd. Improvements relating to heaters for aircraft.

30156. J. M. de Wet. Improvements in articles such as school exercise books used by scholars for writing and drawing upon.

30175. Barr and Stroud Ltd. An improved apparatus for the conversion of motion particularly for use in anti-aircraft gunnery.

30176. Barr and Stroud Ltd. Improvements in or connected with range-finders and height-finders for anti-aircraft gunnery.

30179. M. F. Bradly. Improvements relating to steam traps.

30212. Babcock and Wilcox Ltd. An improved method of and apparatus for recovering chemicals and heat from liquor containing inorganic chemicals.

30213. Barr and Stroud Ltd. Improvements in or connected with range- and height-finders for anti-aircraft gunnery.

30233. Pritchet and Gold and E. P. S. Co., Ltd. Improvements in micro porous materials.

30300. The General Electric Co., Ltd. Improvements in condenser-resistor combinations.

30356. G. H. Barron. Improvements in or relating to tensioning tools for applying tensioned bindings to boxes, chests or other packages of a similar nature.

30486. Prof. M. L. Schorff. Improvements in or relating to dyestuffs from tamarind seed husk.

30655. F. Geiringer. An improved building board made from coir and an adhesive.

30655. F. Geiringer. An improved building board made and resistance to water of fibrous materials such as paper textiles and the like.

30902. International General Electric Co. of New York Ltd. Improvements in and relating to luminescent materials.

30963. L. Gardner and Sons Ltd. Improvements relating to fuel injectors for compression ignition oil engines.

31093. H. A. Whitehead-Kral and Lens and Scientific Instrument Co., Ltd. Improvements in or relating to telescopes.

31229. H. E. Bayliss. Improvements in and relating to methods of manufacturing electrical resistances.

31243. The Mullard Radio Valve Co., Ltd. Improvements in plug and socket joints suitable for electrical conduetors carrying high frequency currents.

31244. Tecalemit Ltd. Improvements relating to oil or other liquid filters or cleaners.

31246. Gillette Safety Razor Co. Improvements in magazine safety razors.

31250. Gillette Safety Razor Co. Improvements in magazines for safety razor blades.

31485. Constructors Ltd., W. C. Scrivener and A. G. Brewer. Improvements in or relating to masts, poles and the like.

29549. Superior Steel Corporation. Improvements in or relating to a method of and apparatus for joining a flanged member and a member adapted to be held thereto.

30066. Standard Telephones and Cables Ltd. Electrical calculating apparatus.

30170. Imperial Chemical Industries Ltd. New monoazo dyestuffs.

30183. The Fine Cotton Spinners' and Doublers' Association Ltd. and Bleachers' Association Ltd. Improvements in and relating to rope.

30215. Hoover Ltd. Improvements in or relating to suction cleaning systems.

30229. P. N. Ottersland. Knife mounting, more particularly a knife mounting for chippers.

30309. Swastik Engineering Manufacturing Co., Ltd. A coin operated automatic vending machine.

30537. P. C. Paul. Cigarette lighter.

30742. E. S. Ezra and S. E. Ezra. An improved joint for copper wires and method of effecting same with copper sleeves reinforced with a copper wire.

30925. William Crawford and Sons Ltd. Improvements in the manufacture of foods especially baked cereal products and compositions for incorporation therein.

30934. N. Bosanquet. Improvements in or relating to the manufacture of edible products from fruit and/or vegetables.

30971. Universal Oil Products Co. Process for producing monohaloalkanes.

30975. Standard Telephones and Cables Ltd. Improvements in or relating to apparatus for testing cables.

30985. F. Porter. Improvements in or relating to electric conductors.

30989. Automatic Telephone and Electric Co., Ltd. Improvements in telephone or like signalling systems.

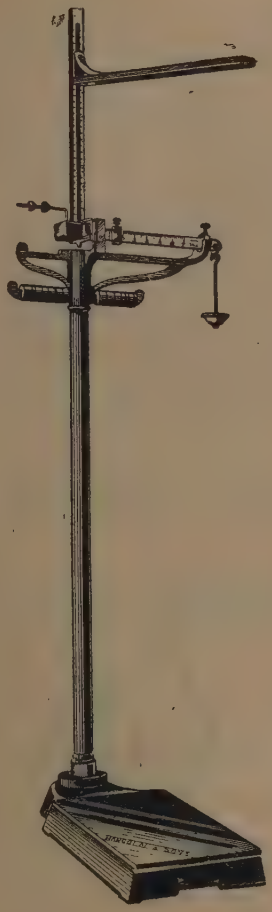
31035. G. N. Banerji. Method of labelling or covering the exterior and/or the interior of a container or other moulded article made from a resinous composition.

31043. Standard Telephones and Cables, Ltd. Voice frequency ringing system for telephones switchboards.

31082. Universal Oil Products Co. Process for the conversion of paraffin hydrocarbons.

31170. Svenska Aktiebolaget Bromsregulator. Improvements in load gear equipment for vehicle brakes.

31194. African Sisal and Produce Co., Ltd. Improvements in the treatment of vegetable waste for the manufacture of filling materials.



★ Electric Oven

★ Combustion Furnace

★ Centrifuge, buckets or basket

★ Vacuum pans and Distillation apparatus

★ Coupiers Still with French Fractionating columns

★ Electric Water Bath and Stills

★ Chemical and Analytical balances

★ Stirring and Shaking apparatus

★ C. P. & A. R. Laboratory Chemicals

★ Precision and Normal Graduated Glassware

★ Resistance Glass, Hard Glass and Jena Glassware

★ Table-blown Glassware

★ Porcelain Crucible and Dishes

Cast Iron Retorts, Metallic Buchner Funnels, Flasks and Beakers and for all sorts of apparatus for Industrial, Technological and Applied Chemistry Laboratories

Please write to

HARGOLAL AND SONS

THE SCIENCE APPARATUS WORKSHOP

Estd. 1897

Hargolal Road
AMBALA
Teleg : "HARGOLAL"

Telephone 173 AMBALA

27A, Linga Chetty Street
MADRAS
Teleg: "HARGOSONS"

IMPORTANT

When the range of available items is becoming narrower due to abnormal conditions, proper selection of one's requirements is of paramount importance. By our ceaseless efforts we have collected, by import and manufacture, a large stock of Scientific goods which will be of much help to all consumers in making proper selection. Please write to us for Balances and Weight Boxes, Barometers, Resistance Boxes, Polaroids, Gas and Water fittings, Colorimeters, Comparators, Hollow glassware, Glass graduates, Chemicals and Reagents, etc., etc.

BENGAL CHEMICAL & PHARMACEUTICAL WORKS, LTD.
CALCUTTA : LAHORE : BOMBAY

Essential Oils

Orange Oil F, Orange Oil D,
Ginger Oil, Mullilam Oil,
Zeodary Oil, Wild Ginger Oil,
Kasturi Manjal Oil.

For Soap and Perfumery Trades

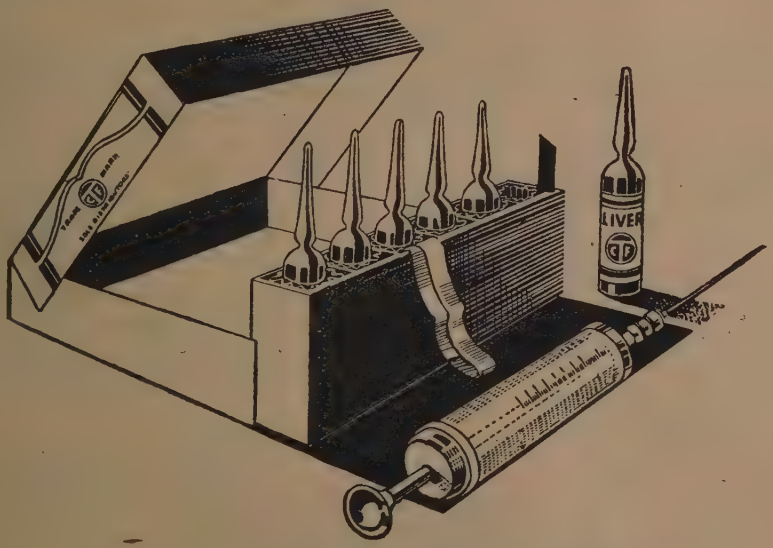
SAMPLES AND PARTICULARS ON REQUEST
FROM
The Business Manager
KERALA SOAP INSTITUTE, CALICUT

T.C.F.

WHOLE LIVER EXTRACT

TRADE MARK

- T.C.F. Whole Liver Extract has remarkable therapeutic value in Tropical macrocytic anæmia and pregnancy anæmias.
- T.C.F. Whole Liver Extract not only contains all the anti-pernicious anæmia factors, but also Whipple's factors, Wills' factors, Thiamin (B_1), Riboflavin (B_2), Adermin (B_6), nicotinic acid (P-P Factor) and Pantothenic acid (Filtrate-Factor) from fresh young healthy sheep liver.
- Packed in 2 c.c. and 5 c.c. Ampoules and 10 c.c. rubber-capped Vials.



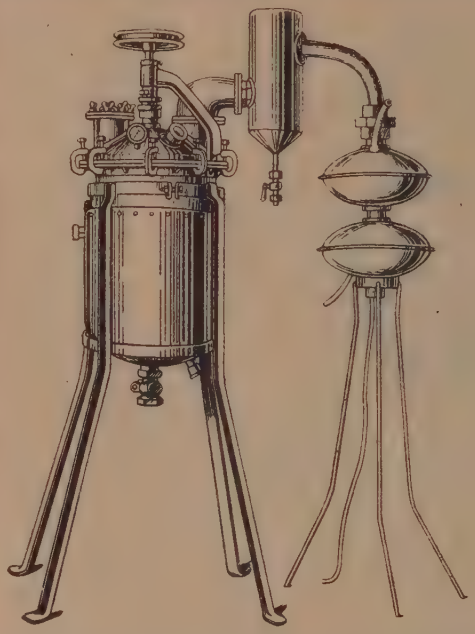
Product of the Biological Laboratory of

TEDDINGTON CHEMICAL FACTORY LTD., BOMBAY

Samples, Prices and Literature, etc., on application to:

Sole Distributors: **W. T. SURÉN & CO.**

'Phone 30861 **BOMBAY** Post Box 229



S. I. E. C. O.

SCIENTIFIC AND INDUSTRIAL EQUIPMENT COMPANY, LIMITED

Manufacturers of Pilot plants for Industry and Distilled Water Stills for Research and Industry.

54-55 Silverjubilee Park Road
BANGALORE CITY

For Sale

Two Brand New Edge Runner Mills, 3′ diameter, suitable for mixing or grinding chemicals, minerals, synthetic materials, etc.

For particulars write to :—
THE WESTERN MANUFACTURING CO.
Hassan Chambers, Parsee Bazar Street
FORT, BOMBAY

for

- **INDUSTRIAL PAINTS for MACHINES, INSTRUMENTS, etc.**
- **ELECTRICAL INSULATING VARNISHES.**
- **"LAKAKI" DISTEMPERS for houses and homes.**
- **PRINTING INKS. Black and Coloured.**
- **"LIGHTNING SPEED" AND "BLITZ" Polishing Compounds.**

Write to

INDUSTRIAL CHEMICAL WORKS

KIRLOSKARVADI
Dist. SATARA.

Aether

OF THE PUREST QUALITY

Alembic

ÆTHER SULPHURIC B. P.

This is pure quality Aether complying with the standards of the British Pharmacopoea. It is used in the manufacture of pharmaceuticals and is also suitable for general use in chemical and technical laboratories.

Available in 1 lb. Bottles and 28 lbs. Drums.

ÆTHER DISTILLED OVER SODIUM

This is chemically pure Aether, free from aldehydes, peroxides and other impurities. It is specially suitable where best quality pure Aether is required for special technical use or in analytical, research and chemical laboratories.

Available in 1 lb. Bottles.

ÆTHER ANÆSTHETIC B. P.

This is highly purified and stabilised Aether free from aldehydes, peroxides and other impurities. It complies with British Pharmacopoea standards for Anaesthetic Aether and is specially prepared for use in hospitals for anaesthetic purposes.

Available in 1 lb. Bottles.

Alembic are pioneer manufacturers of Aether on a very large scale and are supplying it to the entire satisfaction of leading

Alembic Aether

laboratories, colleges, hospitals, commercial firms and government institutions all over India, wherever Aether is required.

AL.179

ALEMBIC CHEMICAL WORKS COMPANY, LIMITED, BARODA.

GUM KARAYA

MAINLY EXPORTED

TO

AMERICA AND ENGLAND

ALSO FOR

TEXTILE, SIZING AND FINISHING

OTHER GUMS

'TRAGAKANTH' For PRINTING — 'ARABIC' For INDUSTRIAL USES

AVAILABLE FROM LARGEST STOCKISTS

CHIMANLAL BHOGILAL

RATANBAI BUILDING, NEW CHINCH BUNDER, BOMBAY

Telegrams "AGMOL" Telephone 27458

S. C. SHETH & CO., LTD.

RAJA BAHADUR MOTILAL MANSION
14, Hamam Street, Fort, Bombay

FOR TEXTILE AUXILIARIES

STARCHES - GUMS
DEXTRINE - DYEING
BLEACHING & FINISHING

PARAFFIN WAX - STEARINE
COLOURS - CHEMICALS
LEATHER & WOODEN

GOODS

FOR TEXTILE INDUSTRY

SACWO
AGRA
Regd. Trade Mark.

"SACWO" RESEARCH AND STUDENTS' APPARATUS

for

EXPERIMENTAL PHYSIOLOGY, PHARMACOLOGY AND PSYCHOLOGY

★ ★

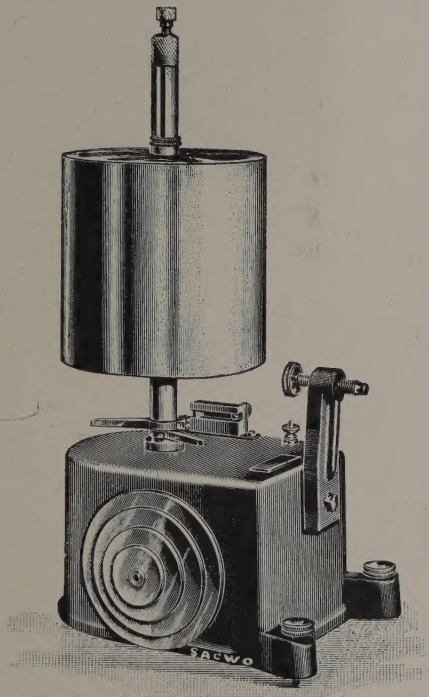
SPECIALITIES

Recording Drums and Kymographs.

Smoking and Varnishing Apparatus.

Livers, Timemarkers and Tambours,

Etc., Etc., Etc.



SPECIALITIES

Operating Tables and Respiration Pumps.

Induction Coils and Keys

Cannulæs and Oncometers,

Etc., Etc., Etc.

★ ★

Write for Illustrated Catalogue from the Manufacturers of

SACWO PRODUCTS

THE SCIENTIFIC APPARATUS & CHEMICAL WORKS LIMITED

Civil Lines
AGRA

Krishna Buildings
Bori Bunder
BOMBAY

For the Nation's Granary..

Obtaining an increased yield of crops from the land is a major item in the plans for the economic development of India.

By furnishing the essential modern implements of agriculture, transport communication and irrigation services the steel industry will help to transform arid deserts into smiling wheat and rice fields.

TATA STEEL

Issued by The TATA IRON & STEEL CO., LTD., Head Sales Office: 102A, Clive St., CALCUTTA

Printed by F. Borton for G. Claridge & Co., Ltd., at the Caxton Press, Frere Road, Bombay.
Issued by the Council of Scientific and Industrial Research, India. Editor: B. N. Sastri, M.Sc.